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IN ALL THEIR DEPARTMENTS.

BY A COMMITTEE OF PRACTICAL SURVEYORS, ENGINEERS, AND ARCHITECTS, OF MUCH EXPERIENCE AND IN ACTIVE EMPLOYMENT.

ROBERT MUDIE, Literary Conductor.

ON ENGINEERING EDUCATION.

BY COLONEL JACKSON.

Mr. Editor,—The accompanying paper was written before I had seen your two last articles on the College for Civil Engineers; and, although we differ entirely as to the necessity of a special school for engineering education, I trust you will oblige me by publishing, in your journal, my opinions on the subject; it is one of such importance that it cannot be too fully considered in all its bearings.

I am, Sir, your most obedient,

J. R. J.

The writer of the present paper was invited, two years since, to become a member of the board of management of an institution then projected, but, as he disapproved of the plan, he declined connecting himself with the institution until it should be altered both in its nature and objects. It was so altered at his suggestions, and he became an active participator in the labour of establishing the College for Civil Engineers, of which he was to have been the resident director.

Circumstances, needless to relate, induced him to withdraw from the establishment about two months before it opened, nor would he have troubled himself further upon the subject, but for an article in the "Mechanics' Magazine," where ridicule is attempted to be thrown upon the course of instruction he had proposed, and which, as was at the time declared in the printed prospectus of the college, had been "*submitted to most competent judges, who had given it their unqualified approbation.*"

Whatever cause the writer may feel he has for dissatisfaction at the treatment he has received from certain individuals, against whose influence it was as irksome as vain to struggle, he will never commit the folly of appeals to the public, which, being followed by replies and rejoinders, usually terminate in personalities and well-merited ridicule. But, while the writer will never descend to the former, or subject himself willingly to the latter, he trusts that, being attacked, he may, in his own defence, explain in his own words the nature of the institution he once hoped to see established, and the course of instruction he was desirous of seeing put in practice. If, as the article in the "Mechanics' Magazine" affirms, that course is "*complex* and *fanciful,*" the fault is with the great men who first devised it; and, as for its "*impracticability,*" it is impracticable to those only who want understanding to comprehend, and ability to execute. All that is asked is an attentive perusal, and the writer will abide by the judgment of unprejudiced readers.

Engineering, generally considered, has of late acquired such a vast extension as to become an almost exclusively engrossing object of both moral and pecuniary speculation; nor is this to be wondered at. Considered as resulting from the increase of industry and from the practical application of the wonderful discoveries of the age, the various departments of engineering science are eminently interesting; while, regarded as facilitating a still greater development of our resources, as a means of extending civilization and its concomitant blessings, the labours of the civil engineer claim our earnest attention both as patriots and philanthropists.

These labours are not only interesting in themselves as works often of great magnitude, requiring much knowledge, and involving great expense, but are of the greatest importance as connected with agriculture, manufactures, and commerce, with mining, with the protection of the land from the encroachments of the sea, from the devastating effects of torrents and overflowing rivers, with the health of our cities, and their supply of water, with the defence of the country in time of war, and with the progress of discovery, the extension of our influence, and the spread of knowledge.

If, then, engineering embraces objects so various, its elements must be proportionably numerous; and, indeed, it will suffice to consider the nature of any public work, to be convinced that there is not a branch of the physical or positive sciences, some acquaintance with which is not essential to the engineer, while he must be a perfect master of many. Suppose a canal is to be constructed; what multifarious knowledge is required, how many objects must be carefully considered before the plan can be determined, and the work set out. What practical skill is required in the execution, what resources must be treasured up against unforeseen obstacles or sudden accidents. Suppose the desirableness of the canal to be agreed upon, whether for the general transit of goods of all kinds, or for bringing to market coals, stone, grain, or other natural productions of the country, or the produce of some important manufactories situated along the line, &c., the first thing to be considered is the capability of the country for the establishment of the canal; this, of course, requires a knowledge of it, and many considerations must be present to the mind of the engineer, when he examines it for the purpose of canalization. If satisfied that a canal may be made, it is then necessary to determine the line of direction between the several places through which it must pass. This line must be the most direct and the most horizontal possible, in order to avoid both expense and unnecessary delay. The highest parts must be so situated as to command a constant supply of the necessary quantity of water, and the lowest must be secured against a dangerous influx. Perhaps the reservoir, or the tributaries, whence the supply of water is to be obtained, are situated at a distance; perhaps a reservoir is to be formed, the waters of surface drainage are to be carried off. All this, and similar considerations, must be taken into account, and before they can be acted upon, an extensive set of levels must be obtained. Supposing the levels taken, the nature of the soil on the proposed line is to be examined; some portions of it may be rock, or clay, or sand, or bog; the rock may be of a nature more or less difficult to excavate, and, as it is always an expensive operation, the cheapest and most expeditious of the known modes must be employed, or a new one devised. The rock may be of such a nature that its debris may be of no other use than for filling up, or it may afford an excellent building or facing material, or be otherwise useful in the arts, if properly quarried for the purpose. But, independent of this, the stratification of the mass, particularly if the line should happen to follow the *anticlinal* axis, may be such, that so much water will be lost by infiltration as to render puddling necessary, a difficult operation in such cases, whereas, if the line should follow the *synclinal* axis of the strata, the superabundance of drainage into that part of the canal may be very inconvenient, and render it necessary to carry off the surplus water by the construction of out-fall drains at the first convenient place. Should the soil be clay or loam, it may be useful for the making of bricks, or quite unfit for this purpose, as when it contains lime: marl may be valuable as a manure for the surrounding country, and good gravel is always valuable. Should the soil be sand, the difficulty of keeping the channel clear is very great, independent of the loss of water by infiltration; and if, therefore, the inconvenience cannot be got rid of by altering the direction, it must be remedied by puddling, or other means. A swampy soil must first be drained; and from the very fact of the waters accumulating there, it is probably low land as regards the neighbouring country, and therefore not easily drained, unless perhaps by boring—an economical method, but which requires much judgment. Should the soil be peat, allowance must be made for, and precautions taken against the rising of the bottom of the excavation, and the collapsing of the sides; and, further, a solid towing path must be constructed. The difficulties, then, which the nature of the soil presents along the proposed line, may be so great as to cause it to be changed, or those difficulties must be overcome by a perfect knowledge of their nature, and by practical skill, or happy contrivance. The exact line at length fixed upon, and the dimensions of the canal as to depth and breadth of water also determined by the nature and extent of the transfers to be effected by its means, and the necessary supply of water estimated, and secured (the latter implying a correct knowledge of the levels of the several water courses, and natural

and artificial reservoirs, with the quantity of water they respectively furnish at different seasons, together with the loss by evaporation and infiltration, both of the supplying waters, and those of the canal itself), how much yet remains to be done in the planning of the details.

Rising grounds are to be cut through in one place, valleys filled up in another, or crossed by aqueducts, the canals are to be carried over hills by means of locks, or made to pass through them by tunnels. In one place, the banks are to be vertical, or but slightly inclined, in another, very sloping; in one place, catch drains are to be made to secure the banks of the canal from the effects of the erosion of rills resulting from surface drainage of higher levels, and the water thus collected brought into the canal, or carried off under it by culverts. In one place, weirs are to be constructed, in another, safety-gates; here the canal is to be connected with a river, there with a lake or an arm of the sea; here bridges are required to carry the road over the canal, there the road is to pass under the canal; in one place, the bank is to be sodded, in another paved; here the direction of the road crossing the line is to be changed, or one made where there was none before; here locks are to be constructed, or their substitutes, inclined planes; there, wharfs, with cranes, and sheds, and store-houses, or basins and yards for the construction and repair of the boats; in one part of the line dead fences or parapet walls are required, in another, quickset hedges are to be planted, &c. All this determined, and laid down, and the plans drawn, the contracts are to be made, the mode of working defined, and the execution of the whole to be superintended.

From this very rapid sketch sufficient may be gleaned to show that there is not a single one of the positive and physical sciences which is not essential to the engineer.

But his labours are by no means confined to the construction of canals, or artificial water courses. He is called upon to drain marshes, to reclaim lands from the sea, by warping or otherwise, or to protect the former from the encroachments of the latter by sea walls, by spurs, or other means, to rescue land from the devastation caused by torrents, and by the periodical overflowings of rivers, to construct reservoirs, and bring streams into them, to raise the water of a river in some parts of its course to a higher level, and keep it there by permanent walls, or embankments, or weirs, or regulate its height by sluices or gates, to draw off water by cuts for the purposes of irrigation, for the service of mills, &c., to render rivers navigable by deepening their beds, by the removal of such obstacles as rocks, shoals, and banks, and to prevent the renewed formation of the latter by securing the river from fresh influx of shingle and silt, and other detrital matter, or by forcing the river to scour its own bed, and keep it clean, to secure the banks of a stream from the erosion of the current, so as its present direction may not change, or to effect a change in such direction by a new channel; he has to draw water from mines, and carry it off, to bring water for the supply of cities by conduits or aqueducts, or to procure it by the boring of Artesian wells; he is called upon to improve or form harbours, by the construction of jetties, and piers, and breakwaters, to excavate docks and build quays, to erect light-houses, some of them in most critical positions, as on tide-covered rocks, and on sandy shoals; he is called upon to choose the most eligible situation for new towns and cities, and to plan them when the site is fixed upon; to him the inhabitants of cities subject to inundations look for the means of securing their lives and properties; to him is confided the tracing of roads of every description, and their construction, from the small byway to the long and perfect high road to be carried over deep valleys, rivers, and marshes, along the sides of precipices, through rocks, and over hills; he has to trace and lay down railroads, to construct bridges of all kinds, and in all kinds of situations, here of wood, there of brick, stone, or iron; in one case resting his arches on piers deep founded under water, in another, abutting them against the rocky sides of some precipitous ravine, or suspending his bridge by chains or rods, &c. &c. Indeed, the attributions of the civil engineer, even in the direct and legitimate line of his profession are innumerable. Independent of this, however, there is a multitude of objects which, though not strictly belonging to the science of engineering, are so intimately connected with it, that, unless the engineer has a very considerable acquaintance with them, he cannot assure to the public the full value of his profession, and is in danger of doing as much mischief in one way as he does good in another, of which, unfortunately, there have been but too many instances.

If the attributes of the civil engineer are numerous and various, so is each of the several kinds of works which we have rapidly indicated exceedingly extensive in itself, there being hardly one of them on which voluminous treatises have not been written; and, if to these we add general treatises on engineering, and particular treatises as on bricks, mortars and cements, carpentry, &c., an extensive list of special publications on particular works, besides those books which treat of the sciences on which all engineering labours are based, we can readily conceive what extent of varied knowledge is required for the exercise of the profession of the civil engineer.

That the acquirements of the civil engineer should be almost universal may not at first sight strike every one, but the ablest men of the profession are fully aware of the fact. Applied to as they are in consequence of their well-earned reputation, for the execution of works of most dissimilar character, or of works of similar nature, but in situations and under circumstances totally different, they feel at every step the necessity of extensive and varied knowledge, the possession of which adds vigour to their conceptions, and assures the success of their operations.

But, though the best informed engineers admit, as indeed it cannot be denied, that the most varied knowledge is indispensable to success in engineering, a dangerous prejudice prevails most extensively, that practice, and practice alone, is all-sufficient to form the accomplished engineer; and, accordingly, we have hitherto been content to have no engineering schools. Our great public works, it is said, and the millions they have cost, * have been confided with perfect success to practical men: but is it so? If by practical men, we mean men who were not educated in any particular engineering school, then they were practical men; but if the usual signification of the term be meant, that is, if we conceive them to have been men who acquired all their knowledge in the way of practice, by merely working under others, and then working for themselves, such is not the fact. Our most eminent civil engineers were men gifted with a natural genius, or men who studied hard to acquire that scientific knowledge which they never could have obtained in the mere way of practice, and without which they never could have achieved those noble works which are the glory of the country, and the imperishable monuments of their own superior talents.

Where, we would ask, did Brindley learn all that enabled him to carry into effect the duke of Bridgewater's vast projects? Certainly not in the workshop of the millwright with whom he was apprenticed; and although he may have watched the progress of the little Sankey Canal, the first and then only one existing in England, and which was not completed when that of the duke of Bridgewater was commenced, he certainly was never employed by or under Henshaw, and had, therefore, no practice in canal making. It was his natural genius, then, aided by that intense application and extraordinary memory, for which he was remarkable, which alone enabled him to rise from the millwright's shop, and the construction of machines, to become the greatest engineer of his day in his own country.

Telford's early practice was as a stone-mason, but he was, almost from infancy, a great reader: he made himself master of the scientific parts of architecture, and taught himself Latin, French, and German,—the latter languages, certainly, that he might enlarge the sphere of his ideas by an acquaintance with the professional labours of France and Germany; and, though he is said to have preferred having recourse to experiment rather than calculation, he is known to have learnt algebra:—above all, he was a man of genius. The same may be said of the late Mr. Rennie. This great man, whose early practice was as a machinist, acquired a knowledge of some of those sciences so essential to the engineer. At the age of sixteen he was a proficient in mathematics, and, at Edinburgh, he studied natural philosophy and chemistry; and although he esteemed science but little when inapplicable or unapplied, he delighted in those investigations where theory and experiment assisted and confirmed each other. He was a scientific as well as a practical man, as is proved by his instrument for ascertaining the strength of running water; moreover he was, as we have said, a man of extraordinary genius.

Watt, to whom we are so greatly indebted for his invaluable im-

* The works executed by the late Mr. Rennie alone are calculated to have cost fifty millions, of which twenty passed through his own hands.

provements in the steam engine, was himself indebted entirely to his own genius, and his indefatigable pursuit of various branches of knowledge, particularly mechanical science, for his wonderful success. Indeed, so little did he owe to others in the practical way, that he could learn nothing from the engine of Newcomen but its imperfections, and had himself to discover the properties of steam, under different circumstances, before he could appropriate to the more successful application of that powerful prime-mover those ingenious contrivances which have immortalized his name. But why should we increase the number of our examples, it is notorious that practice alone, though it may make a good workman, can never make an able engineer; and that all those great men who have been pre-eminent in the profession possessed, together with practical ability, a vast fund of scientific knowledge, the talent of acquiring it under great disadvantages, and the genius to apply it when acquired. They were not great because they did not study in engineering schools, but they arrived at greatness despite the want of the facilities which such establishments would have afforded them.

We know it may be said that to the public it matters little how men become efficient for the execution of great national works, provided they are efficient, and execute them with success. But against this opinion two powerful objections may be made. First, it is with genius, as with other commodities, the supply is not always equal to the demand. When engineering works increase, the number of engineers must also increase; but genius is a spontaneous present of nature which she rarely makes, and in making which it does not appear that she is at all influenced by the development of human industry. As civilization advances, it affords to existing genius more opportunity for display, but can never create genius where it is not. And thus, although at a time when great engineering works were much fewer than they are at present, engineers of genius may have been sufficiently abundant, we cannot expect them, however much we may wish it, to spring up like mushrooms, and supply the constantly increasing demand for them. Secondly, experience, we all know, is an excellent instructor; but we know, also, that the lessons of this master are the most expensive and the slowest in producing fruit. In learning to conduct, as the Americans express it, that is, to conduct ourselves through life in our social relations, the rude lessons of experience are paid by ourselves individually, and the heavier penalty of our ignorance falls upon ourselves. Not so in learning to conduct great public works; for here, before efficiency is acquired by experience alone, not only is much valuable time lost, but, what is equally to be deprecated, much capital is wasted. The blunders committed in engineering through ignorance, though they may eventually render a man efficient in his calling, are of too expensive a nature in themselves, and bear too heavily upon the public, for it to be a matter of indifference whether the efficiency of engineers be acquired in this or any other way. Moreover, there is little probability that efficiency will often be acquired, even at so dear a rate; for the unfortunate man whose ignorance of his profession has occasioned great loss to the public is little likely to be again employed, though on a future occasion his acquired experience might insure success, so that the public pay for an experience from which it reaps little or no benefit. If the lessons of experience are consigned in the archives of science, they may be eminently useful; but to be so they must be learnt; but to learn them from books is to acquire the theory of engineering, against which the ignorantly practical public are continually railing; although it is by a perfect knowledge of theory only, which is but another name for the methodized results of long practical experience, that national works can be executed successfully at the least expense, and in the shortest time. We therefore say, it is by no means a matter of indifference to the public how engineers become efficient; and to rely wholly upon genius, which is scarce, and upon unenlightened practice, which is expensive, is most unwise in principle, and of most ruinous consequence. But let us look a little closer into what is called practice. Practice is the repetition of some action, either with a view to become perfect in its performance, or is necessarily acquired in the line of our profession, in which case dexterity as naturally results from the habitual performance of the action as if the attainment of perfection were the sole motive of practice. In practising music, we repeat the same piece over and over scores of times, till our execution of it be perfect; this is intentional practice. By dint of amputating legs and arms, a surgeon acquires dexterity in the operation, though no one would let him cut off their limbs that he might become perfect by practice. Engineering practice must be adventitious only; that is, it is confined to the repetition of necessary operations performed in the course of professional labours. Embankments, bridges, &c., cannot be constructed, pulled down again, and re-constructed for the sake of practice, though they sometimes very obligingly fall down of their own accord, and have to be re-constructed, by which the engineer acquires a good practical lesson; at the expense, however, be it remembered, of his employers, and of a portion of his reputation. Practice, then, in engineering, is confined to adventitious repetition of the same operations; but it too seldom occurs to the same individual to repeat precisely the same operation, for him to become perfect in its performance by dint of repetition. Embankments, for instance, frequently occur, but the locality, the purpose, the materials, differ, all circumstances which induce great modifications in the mode of construction; and, although the engineer may have constructed excellent embankments before, the fresh operation may be as new to him as though he had never made an embankment in his life;—his practice, therefore, in this case can avail him little. The same is the case with bridge building; the depth of water in the river, the nature of the bottom and of the banks, the nature of the bridge itself that an engineer is called upon to construct, may be quite different from any thing he may before have met with, though he may have constructed a few good bridges. What shall we say of regulating the course of rivers, the most difficult, perhaps, in itself of all the labours of an engineer, and that in which practice, supposing him to have any, can little serve him, as the circumstances connected with the subject are almost as various as rivers themselves are numerous. But, not to multiply instances, it will suffice to observe, that in the whole list of great operations confided to an engineer, and which we have before briefly enumerated, there is not one which the same engineer will be called upon to perform in exactly the same manner and under the same circumstances: practice, therefore, as far as complete works are concerned, can teach the engineer little or nothing. Not that we would infer that there is no such thing as practice in any of the departments of engineering, but we would point out the extent to which it is of necessity limited. It is limited to certain details of more or less frequent recurrence, and to a few general preliminary operations, which must be performed, though the works to be executed may be very dissimilar.

The details connected with the labours of the engineer, in which practice may be useful, are such as are usually executed by contractors, or by the persons they employ, so that an acquaintance with them might, to a certain extent, appear to be not altogether necessary to the civil engineer; but he should know them well for two reasons;—first, because if he be ignorant of them, he cannot judge properly of the quality of the work done by others; and, secondly, because he may be called upon, both at home and in the colonies, not only to execute by himself all the parts of his own plan, but also to teach his labourers how to work. Not but that many of the details to which we allude are fully explained in elementary works and particular treatises, where they may be learnt, but there is in all the arts a number of minutiæ which could not be described in books without an overwhelming prolixity, but which are essential to success, and can be thoroughly known and fully appreciated by practice alone. To enumerate these details would extend our remarks far beyond the limits we have prescribed to ourselves; we allude to such as the following:—the modes of excavating in different soils; the wetting of the spade in digging clay; the wetting of bricks, or using them dry, according to circumstances; the distinguishing, by close inspection of stones apparently uniform in texture, the way in which they lay in their natural bed, so as to place them in the same or some other direction in masonry, as the case may require; the doseing and mixing of the ingredients of mortars and cements in conformity with the quality of the lime; the judging of this quality by simple inspection before or after burning, as also of the quality of all rough materials, which can hardly be accomplished but by constantly having them before our eyes; the judging of the extent and settlement of various kinds of masonry under different seasonal circumstances, and according to the rapidity with which a wall is carried up; the settling of mounds of earth also, under various circumstances, &c. &c.—Such and numberless other details, all more or less important, must be learnt by

what is termed practice, or by actual and repeated observation. The most trifling are important. By the wetting of the spade in digging stiff clay, twice as much work may be done in the same time and with twice as much ease as could be effected without this simple precaution. The schoolboy, ignorant of the fact that to cut caoutchouc the knife must be wetted, hacks, and saws, and tugs, with little or no effect, while a more knowing one takes the penknife, wets the blade in his mouth, and the separation is performed with ease, with speed, and neatly; so is it in the minor operations of the engineer's art; and, as the perfection of the whole depends on the perfection of the parts, the practice of details is essential to the engineer. A dam was constructed in which the mortar used was mixed with unwashed sea-sand, efflorescence soon took place, adhesion was destroyed, the dam fell, and great was the devastation and loss sustained.

The general preliminary operations to which we have alluded, and which are applicable alike to different works, are such as surveying and levelling. Here theory and practice must go hand in hand, and, indeed, if either can do without the other, it is practice which is the more essential. Many a man can very accurately survey a portion of land by dint of practice who knows little of theoretical geometry, of trigonometrical calculations, or the complicated problems of the higher branches of geodesy, while a first-rate mathematician, unaccustomed to the use of surveying instruments, and unpractised in the actual labour of surveying, would make but a sorry surveyor. The same may be said of levelling, an operation which when carried over an extensive space is often intricate, and always requires that kind of skill which long practice can alone give. The same is also the case with many other preliminary operations, such as the general inspection of the ground, by which its capabilities may be roughly estimated, an operation which requires so much practice that what may be termed the *engineering eye* can no more be formed without it, than the military eye of the general, so indispensable to the success of his tactics.

It may appear to some that we have too limited an idea of the extent to which practice can be useful to the engineer; this, however, is far from being the case, for, as we have said, there are details much too numerous to be specified, in which practice is not only useful but essential, and there are many more general preliminary operations in which an engineer becomes perfect by practice than we have enumerated.

It must also be observed that there is a confusion of terms, and what by many is termed *practice* should be called *experience*, for that is what they mean. Now no one can deny that the more experience an engineer has in his profession, the more competent he will be to execute any great works which may be confided to him. Practice is only a part, though an essential part of experience; but experience embraces a much wider field, it includes observation and study. Thus, in the course of some great work, the subordinate engineer may be practically acquainted with very little or no part of it; but, by dint of observation, he learns how the various operations are performed, and he notes the advantages or disadvantages of the methods employed, their success or failure, and the knowledge thus acquired is treasured up in his memory or his note book to serve him on a future occasion: add to this, that, his attention being particularly called to certain operations, he reads and studies the subject, and thus, by combining theory with observation of the practice of others, he learns many things which he has never practised himself, and which no theory alone can teach him so well. Now, as this applies to every department of engineering, it must be acknowledged that a certain time employed at or upon the works themselves is indispensable in engineering education, if not in order to practice, at least to see the actual results of practice, the modes which long practice in different kinds of work have pointed out as the best. Some operations certainly may be learned at other places than at the works, but they are few in number; for the greater part, owing to their magnitude, can be learned only at the works. Thus experience is acquired, and none but experienced engineers should be entrusted with great national works. So much then for what is usually termed practice, by which experience is meant.

What now is *theory?* This term, like the term *practice*, of which we have just spoken, is much misunderstood; but, the mistake is more excusable, as the word has, in reality, a vague signification. Thus theory often means what is merely speculative or hypothetical, but it also means the principles of an art or science, the positive and methodized results of experience. That theory, in the sense of speculation or hypothesis, is of little use to the civil engineer will readily be granted; nay, more, we are of opinion that it is detrimental. Systems when not founded on experience, or when based on partial and imperfect experience, are often found totally erroneous when their application is attempted, and such attempts have too often proved of most serious consequence to all concerned. But theory, in the sense of the methodized results of experience, not only can never mislead, but is of the highest importance.

The theory of drainage, for instance, is founded upon that general law of nature by which water ever flows, when unobstructed, to the lowest level, and consists of the application of this law to particular cases, as resulting from much practice and long experience in clearing land from their superabundant fluid. There are various ways of operating according to the extent of the land to be drained, the nature of its soil, the causes which occasion the water being collected on it, and the direction and nature of the slopes by which it may be carried off. Now from time immemorial drainage has been practised, and under every complication of circumstances in a great variety of ways, and with more or less success. The result of all this experience is consigned as matter of fact, and composes the theory of drainage. Now, as no individual, particularly in the commencement of his career, can have had practice in every kind of drainage, or even have seen it performed under the various circumstances that present themselves; it cannot be denied that he who has acquired a perfect knowledge of the theory of drainage is much more likely to proceed, in any operation of the kind that may be confided to him, upon sure and unerring principles than another who has no such knowledge. The same may be said of the theory of bridge building, of embanking, of road making, &c., so that the engineer who has theoretical knowledge is a more efficient engineer than he who has it not. We have said that practice or experience is necessary: theory is so likewise; indeed, the simplest practical operations performed by the mason, the carpenter, the excavator, &c., are but the applications of theory. Regarding theory and practice the natural order is this, first, blind experiments, then the practice or frequent repetition of those modes of operating found by experience to be the best, and, ultimately, the consignment and methodical arrangement of these modes for the use of future practitioners, which last is theory.

Experience can nowhere be acquired but at the works; theoretical knowledge may be obtained in two ways, either by private study or public tuition. Private study has certainly this great advantage over every other, that, whatever is learnt in that way is generally well retained, and the reason is obvious; private study argues an ardent desire to learn, and that which we do willingly we are the more likely to succeed in. Besides, the want of assistance compels us to turn a subject over and over, in order to understand it properly, and this exercise imprints it forcibly upon the mind. On the other hand, there are many subjects which cannot be mastered without assistance, and with which, therefore, private study affords us but a slight acquaintance; neither does it hardly ever happen than a young man, so circumstanced as to be under the necessity of teaching himself, is in possession of those various adjuncts, a well chosen professional library, plans, models, &c., which are so essential to a good engineering education; so that the progress of the self-taught is comparatively slow, and his knowledge necessarily very imperfect on many points, till it is improved by experience. It is true that a few of our greatest engineers have been self-taught, but the number of such is very limited indeed; and they were men of extraordinary genius. The greater number have all been taught more or less, and those men who could make such progress by dint of their own unaided exertions, or with only partial tuition, would, with the same ardour for knowledge, and the same indefatigable study, have derived the greatest benefit from a regular professional education, and been earlier fitted for their important duties. We come now to public tuition. But first let us enumerate what are the sciences necessary to the civil engineer. We have already said that there is not one of the positive and physical sciences with which he should not have some acquaintance, and that he must be master of many.

Mathematics and mechanics, in all their branches, pure and applied, rectilinear and spherical trigonometry and levelling, con-

structive and analytical geometry, descriptive geometry or projection, civil architecture and general construction, drawing in all its branches, land and water transport, are all absolutely essential, and to which should be added, as almost equally so, geology, mineralogy, and mining, with certain parts of physics and chemistry, particularly that branch of the latter which treats of metallurgy, naval architecture, and a general acquaintance with military architecture, the laws of property as connected with the projects of the civil engineer, and certain branches of statistics. As for languages they may be dispensed with, but would be eminently useful. French is not only necessary as one of the elements of a liberal education, but as particularly useful to the engineer by reason of the many admirable scientific treatises on the various departments of engineering, and its collateral sciences, which are written in that language. The German is also useful for mining details, physical geography, and general science. In the Italian language will be found some of the ablest treatises on the management of running waters; for the devastations to which Italy is subject from the constant overflowing of its torrential streams had early drawn the attention of the Italian engineers to this important subject. An acquaintance with the Dutch language would open to the engineer a mine of interesting information on embanking and draining.

The importance of these various branches of knowledge to the engineer will be evident upon the slightest consideration. Without mathematical knowledge, taken in its widest sense, including mechanics and geometry, it is impossible for the engineer to estimate either numerical quantities, or dimensions, or forces; and, as all these must be determined before he commences operations, he cannot proceed if unacquainted with mathematics. Trigonometry, rectilinear and spherical, the former especially, he must be perfect in, and also in the practice of levelling in all its departments and according to different methods, so as to be able to adopt each according to circumstances. Without descriptive geometry no working drawings for stone cutting and carpentering, &c., can be made; nothing drawn correctly in linear perspective, or be properly shaded, or coloured according to the laws of aërial perspective, no maps constructed according to either the orthographic, the stereographic, the central, the conical, or any other mode of projection. Civil architecture is essential to the engineer, who must frequently unite in his own person the profession of architect with that of engineer. General construction, as being the most important branch of engineering knowledge, and as embracing so great a portion of the attributes of the civil engineer, we shall consider presently by itself. Drawing is the language of the engineer; without it he can neither receive nor communicate information on the subject of his profession. Land and water transport the engineer must be familiar with; for he has to consider the various forms of vehicles, their defects and advantages, the loads they carry, their usual speed, their effect upon roads, the power of draft cattle of different kinds, and yoked in different ways, &c., whenever he is called upon to construct a road; as the nature of the latter must ever be determined by the nature and extent of the traffic to be carried on by its means. Of water transport, he must know the nature of the articles usually transported on rivers and canals, the forms, dimensions, tonnage, and draft of water, of the various kinds of river craft and canal barges, the speed up and down on different rivers at different seasons, the speed on canals, and the effect of this speed on their banks, so that they may be secured accordingly, &c.; the navigation of lakes, and that along the coast the engineer, should not be ignorant of.

Hydrography is of the greatest importance to the Civil Engineer. He must be well acquainted with all the details of the coast, its several bays, roadsteads, creeks, ports, and harbours; its promontories, cliffs, beaches, and banks: and all the changes which take place along the coast, with their several causes; for without such knowledge he can never devise the best means to be employed in the several cases where his professional ability is required, nor be certain of the ultimate success of his measures; and, as engineering labours on the coast are extensive, and require an outlay of money proportionate to the power of the element to be controlled, ignorance of any part of the knowledge required for their success is sure to be attended with the most ruinous results. But hydrography is not limited to a perfect acquaintance with the coast; the inland waters of the country, and every thing connected with them, should be as familiar to the engineer as his alphabet. Every river of the country of any importance should be known to him, from its source to its mouth, with all its affluents, its length, breadth, and the direction of its course, the nature of its bed and banks, the rapidity of the stream, its liability to inundation, or to lack of water; the height to which the tide ascends in it, the distance to which it is navigable for different kinds of craft at different seasons, or the obstacles to navigation which it may present, with the degree of facility for the removal of these obstacles; the kind of country through which the river flows, its consequent importance to commerce or agriculture, &c. He should in like manner know the position of all the lakes of the country, their dimensions, and height above the level of the sea, and the whole system of existing canals, with all their leading features.

Geology is of great use to the engineer, in many of his operations; and without a knowledge of mineralogy he can be but imperfectly acquainted with a great part of the materials he employs. Mining, to a certain extent, including quarrying, is a useful branch of knowledge to the engineer; not only because he has frequently to work under ground, and make excavations upon mining principles, as in sinking wells and shafts, opening galleries and tunnels, &c., but, because, without a general knowledge of mining, he cannot adopt the several modes of clearing mines of water, each of which work the best according to circumstances; a duty he is not unfrequently called upon to perform.

Physics, or natural philosophy, is essential to the engineer, for without it he can know nothing of acoustics, which in his capacity of architect he should know, or of hydraulics, hydrostatics, and hydrodynamics, which he must be a perfect master of, or of the pressure of the atmosphere and its other phenomena, or of heat and cold, siccity and moisture, and their effects on metals and other bodies. In short, there is hardly a step the engineer takes, in which a knowledge of natural philosophy is not of the greatest service to him. Chemistry, particularly that part of it called inorganic chemistry, is also very useful to the engineer on many occasions; metallurgy enables him not only to judge of the quality of the metals he has to employ, but instructs him in the modes of obtaining them from their ores, an operation he may sometimes have to perform in distant colonies. A certain acquaintance with vegetable physiology, inasmuch as the growth of timber is concerned, would often be found advantageous, as so much of the strength of wood depends upon the place where it is grown, the soil, the aspect, the age of the tree, the time of the year when it is felled, &c.

Naval architecture, to a limited extent, is necessary for the civil engineer. He should know the construction of canal and river craft; and the fitting-up of steam-engines in vessels (now included, though we think improperly, under the head of engineering) renders necessary a knowledge of the build of ships.

Military architecture, or fortification, does not come strictly within the province of the civil engineer; nevertheless, without some knowledge of it, an engineer cannot so well combine his plans in the formation of ports and harbours, or protect fortified cities by artificial inundations, or choose the sites of cities that are to be fortified, &c. In continental countries, a certain knowledge of the strategetical operations of armies is essential, for without it a new road may be planned in a manner most injudicious, as regards the safety of the country. The laws of property, as connected with the projects of the civil engineer, is a very useful branch of knowledge; as, without this, the engineer may get himself, or his employers, into serious difficulties, or be wholly at the mercy of pettyfogging lawyers, and subjected to continual annoyances. Geography, particularly that portion of the general science which is denominated physical geography, is of much use to the civil engineer; while certain statistical data are also necessary to the forming of great engineering projects. History has little connection with engineering, but is a necessary part of that liberal education which every man, exercising important functions, should receive. We shall now say a word of general construction.

This object embraces so much, that what in engineering education is called the course of general construction, or, simply, course of construction, might as well be termed a course of engineering. It is divided into two parts: in one, the objects are of a general nature; in the other, they are of a specific character.

The first part includes generally—

The knowledge, *a*, of all the materials used in engineering labour of every kind; and, *b*, of the powers employed in the use of these.

Secondly,—The details of execution of any projected work; *c*, the preliminary labours; *d*, the laying out of the work; *e*, its actual execution; *f*, responsibility.

The second part, still more extensive than the first, comprises the special knowledge requisite for the execution of the several engineering labours, which are enumerated at page 194.

a The materials with which the engineer has to deal are the several kinds of earth, stones, wood, and metals; bricks, tiles, mortars and cements, cordage of all kinds, paints, varnishes, &c. Regarding every one of these, he must learn many particulars; such as their solidity, strength, specific gravity, their degree of durability under different circumstances, their scarcity or abundance, their price at the market, or place of production, the expense of transport by different means, and the mode of estimating it, &c.

b The powers employed are, men, animals, wind, water, or steam, acting directly, or by means of machines. Of these several forces, the engineer must know the extent and respective advantages in different circumstances; as also the amount and value of the labour that can be performed by each, in a given time, with its price, &c.

c The general preliminary labours have been already briefly mentioned at page 196; they consist in a matured consideration of the nature and objects of any proposed undertaking, in order to determine, first, the possibility of its execution, and whether or not the advantages are such as to warrant the presumed outlay; secondly, the inspection of the scene of operation, the necessary surveys, levelling, sounding of dead water and calculation of its quantity, as the cubical contents of lakes, reservoirs, and ponds, estimation of currents, and of the quantity of water which passes any place in a given time, borings, experimental essays, as on the permeability of soils, &c., with the price of such labours; measurements, drawings of all kinds, models, estimates, general and detailed memoirs, &c.

d The laying out of the works comprises their distribution in such manner that the whole may be executed in the best, the speediest, and the most economical manner; the establishment of the magazines or storehouses, the workshops and the machines, the supply of materials, &c.

e The actual execution includes a perfect knowledge of all kinds of construction, properly so called; such as embanking and excavating, in all their variety of circumstances; foundations of all kinds, and in every kind of soil; caissons, pile-driving, &c., scaffolding, centering, raising of heavy masses, &c., &c.; every one of which objects alone embraces a multitude of considerations and details of execution.

f The responsibility includes the direction of the several agents, the police of the works, the health and safety of the workmen, the keeping of the books and accounts, and the general surveillance.

From these objects, which are of a general nature, let us pass to those which are special. These are so numerous that their mere terminology would occupy pages. We must therefore confine ourselves to a few particular heads. Such are roads of all kinds in plains, and in mountainous countries; the modes of constructing paved ways, and employing regular paving stones, or boulders; macadamized roads, and such as are of gravel or flints, or other material. Wooden roads, whether of trees laid crossways, and called corduroy roads, or of planks, or of branches and fascines, or of regularly cut and laid blocks; common earthen roads; railroads, and roads of mixed character; their side plantations, hedges, ditches, footways, &c.

Bridges of all kinds, whether permanent, such as aqueducts and viaducts, wooden bridges, stone and brick bridges, cast or wrought iron bridges, suspension bridges, &c., or moveable, as pontoon bridges, drawbridges, sliding and turning bridges, and flying bridges. Tunnels, and other subterranean galleries.

In connection with internal navigation, which may be effected either by natural or artificial water courses, the following objects of special instruction must be learnt. The tracing of channels, and laying down of buoys and beacons of various kinds, at the mouths of navigable rivers, the establishment of towing paths, &c. Regarding the rivers themselves, the labours to be executed in such cases as when the rapidity of the stream is too great, or when there is an insufficient depth or quantity of water; or where cataracts, rapids, interrupting rocks and banks are met with; the necessity of keeping the river in its channel, of directing its course, protecting its banks, &c. The establishment of gates, dams, weirs, &c., bringing water into the river, or drawing some of it off, &c. The tracing and construction of canals, and every thing connected with them, embracing most extensive and various details of construction.

Connected with external or coasting navigation, special construction comprises the forming of ports and harbours of every kind, and in very different circumstances, with their sea walls, piers, and jetties, quays, basins, docks and yards, light and signal houses, batteries, &c. The deepening of ports and channels by various means, as dragging, scouring, &c. For towns and cities, the planning of the same after the site has been chosen, so as to secure all the advantages of easy communication, good circulation of air, and surface drainage, sewerage, supply of water, &c.

Such are a very few of the objects comprised under the head of general construction, a course of which constitutes the essential part of engineering education, and which accordingly forms a prominent feature of, and occupies an important place in, every complete system of instruction intended for those who are to become civil engineers.* The French have published some excellent and very complete works on this subject, and the course professed at one engineering school abroad, with which we are particularly acquainted, is elucidated by no fewer than nine hundred figures, comprised in two hundred plates; a sufficient indication of the magnitude of the object. On any number of the objects contained in this course of construction, the pupils must answer fluently, construct and explain in public, before he leaves the school.

We have said nothing of machines, and our reason is, that, although the custom now prevails very extensively among mechanicians of calling themselves engineers, we do not consider them as belonging to the profession of civil engineers,— not but if etymology were, in this instance, to be our guide, the constructor of a steam or any other kind of engine would be better entitled to be called an engineer, than the constructor of canals, harbours, &c. But, by pointing out, as we have endeavoured to do, though rapidly, the various labours of the civil engineer, we have sufficiently specified the nature of the profession to which we particularly allude. The making of machines is a trade of itself, a speciality, a highly useful and most interesting branch of industry, and one which requires much scientific knowledge and practical skill, but it is confined in its nature, and is essentially distinct from the multifarious attributions of the civil engineer. Much of the knowledge required by the engine-maker may be acquired in colleges or schools where civil engineering is the special object, but without years passed in the workshop there is no making a mechanician or constructor of engines. We therefore leave this important class of men to be educated according to a system whose adequacy is fully proved by the unrivalled beauty, power, and perfection of those wonderful machines, which are at once the source of our wealth and the envy and admiration of the world.†

We have now enumerated the sciences necessary for the civil engineer; we next come to the consideration of the way in which they may be best taught. We have said a word of private study; there are two other modes of educating engineers: the one hitherto practised among us, and that which has been followed abroad. Our practice, for system it cannot be called, has hitherto been that of apprenticing to engineers of greater or less eminence such young men as are destined for the profession. The sums paid by parents for thus apprenticing young men varies according to the reputation of the engineers with whom they are placed, and, in all cases considerable, in some it amounts to no less than £1000. For this the young man has what is termed the run of the office for a certain number of years, the parents having to clothe and maintain them all

* How much of all that we have enumerated is taught in an engineer's office, may be ascertained by questioning any young man who has had the run of one; and, until it can be proved either that such things are adequately taught by the plan of apprenticeship, or that they are not necessary to the civil engineer, we maintain the urgent necessity of a special school.

† Though we are of opinion that engine and machine making cannot be taught in a school, yet, as the civil engineer has constantly to employ machines and engines of all kinds, he must, of course, be made acquainted with their construction and use; and, as the steam engine, in its various forms, is now the great mechanical agent, its construction, capabilities, and various applications, should be well known to the civil engineer; and this was accordingly provided for in the course for the College for Civil Engineers, as proposed by the writer.

the time, to supply them with instruments, books, &c. It is, of course, understood by many, that a young man so placed is to be *taught* his profession, but with, perhaps, the exception of some rare instances, where the gentleman with whom he is placed happens to have a larger share than common of conscientiousness, and very little to do, the youth is left to *learn* his profession as best he may. Nor do we state this in reproach to the profession. An engineer of eminence has not a moment that he can call his own; he cannot, therefore, be expected, nor is he, indeed, expected by those who know any thing of the matter, to give lessons and lectures to the young men in his office, nor, if even time allowed him, could he do it if he would; for where is the individual, however able he may be in his profession, who is competent to teach all that we have enumerated as necessary to a complete engineering education? Why, then, it may be asked, is the money taken? For the very plain reason, that all men will take money whenever they can get it, in what is termed an honourable way. There are no engineering schools, and engineers must be had, competent or not. The career, if ordinarily successful, is both honourable and lucrative; parents, therefore, very naturally wish to bring up their sons to it, and, having no other resource, give the required premium, and the young man, after a little drawing, account-keeping, measuring, and having been occasionally sent to the works to see what is doing, or, perhaps, if by dint of extraordinary diligence and natural aptitude he be found competent, having been occasionally entrusted with the superintendence of the workmen, at some cutting or embankment, &c., at length comes home, how much wiser than when he went we will not pretend to say. If the engineer with whom he was placed had works in hand of various character, the young aspirant may certainly have acquired the knowledge of the fact, that engineering has many distinct branches, but the greater the variety of labour in the office the less perfectly will he have understood the particular nature of each. If, on the other hand, the engineer devote himself especially to one or two particular branches of his profession, the student may know these better, but he will have no idea of any thing beyond; and, yet, it will perhaps be said, all our engineers are formed in this way. Granted; but so much the worse. How few of the great numbers of those who embrace the profession arrive at eminence, and how much time is required before those who do, at last, are competent to undertake great and important works? Their education, so far from being completed when they leave the office, is hardly commenced; for theory they have none, and about as little experience, except in the routine of office duty. We have ourselves questioned young men who had been for years in engineers' offices, and found them ignorant beyond what could possibly have been conceived. Neither is it sufficient that we are told to look around us at the great works with which the country abounds. Great they unquestionably are, and justly may we be proud of them; but, by showing us what has been effected with the imperfect mode of education hitherto followed, we are only made the more keenly to regret what might be effected by a better system of training. Besides, while attention is constantly being directed to whatever succeeds or is well done, little or no attention is paid to the numerous bunglings and failures that are daily occurring through ignorance; and, if a profit, however little, is secured upon any great undertaking, the enormous waste of capital incident upon false calculations and imperfect execution is little heeded.

Against theoretical instruction, our so called practical men are ever railing, but this proceeds from so erroneous a notion, so absurd a prejudice, as to be hardly worth refuting. Every thing which the practical man does is the result of theory, and every thing new which he may occasionally effect is the result of the slow process of trial and experimentalizing — the attainment, at the expense of much time, labour, and waste of money, of that which the calculations of science would immediately, and with greater certainty, have either pointed out at once as impracticable, or shown how best to accomplish.

The fact is, on the continent, they are, perhaps, too exclusively theoretical, while we are too exclusively practical. But if our neighbours have less practice than we it is not because they underrate its importance, but because their political institutions and their social organization have both been unfavourable to the development of that enterprising spirit and those united exertions which, with us, have attained such unparalleled extension. But the time will come when, freed from the oppression of arbitrary rule, and no longer diverted from the consideration of their best interests by the political bickerings of party spirit, the people of the continent will turn their attention with energy to industry, and, aided by science, outstrip their models. Even now, foreign engineers profit at our expense; they bring the light of science to bear upon the practice we have learnt at much cost, and adopt, without trouble, the results of our experience; while we are content to work in the dark, and pay dearly for what we might obtain with much more ease, but for the shackles of blind prejudice. Had our engineers received a truly systematic education it is not too much to aver that we might fifty years ago have reached the point we have but now attained, and have at the present moment made much greater progress than, according to the present practice, we shall be able to make for, perhaps, fifty years yet to come. Let us, then, no longer rely upon groping our way in order to arrive at the goal, but let our engineers be well provided with the bright lights of science, and then, with our native energies, perseverance, and enterprise, we shall effect that to which our present triumphs will appear as trifles; then shall we continue to maintain that supremacy which otherwise will ere long be wrested from us.

A better system of engineering education then is a desideratum, and this can only be effected by a school specially organized for the purpose.

We offer, with deference, our opinion of what such an establishment and its organization should be, and, first, of its principles.

In some respects, perhaps, it were to be wished that the government would with us, as is the case in other countries, establish and maintain a college for civil engineers. But there are, on the other hand, reasons fully as cogent against this; besides, it would be a deviation from the universal principle of the country, which is non-interference where private interests are concerned, and every thing appertaining to engineering is, with us, private speculation. Such a college, then, must be established and managed by private individuals; but, unlike joint-stock concerns, where the pecuniary advantage of the parties is the avowed object, the greatest care should be taken to divest the establishment of every trace of a mercenary character, and this, for two reasons. First, education is of itself too noble an object to be converted into a means of aggrandizement beyond the necessary remuneration of those whose time it employs; and, secondly, because as such a concern, in order to be properly carried out, is very expensive, while it is an object to give the education as cheaply as possible, its whole surplus income should be employed in increasing the efficiency of the establishment. Nor is it enough that such disinterested principle be set forth: a guarantee should be afforded to the public that it will be maintained, and this guarantee should be secured by the high moral character of the managers, and an annual public statement of the amount and appropriation of the funds.

Besides this disinterestedness, as regards money matters, the greatest liberality should prevail, as regards religion and politics. Deeply is it to be regretted that religious and political animosity should be eternally blended with the most ordinary occurrences of civil life, but as we must take the times as we find them, our institutions must be modified with wisdom, according to existing exigencies. No education can be complete without religious instruction; nay, without this all other instruction is dangerous; but, while religious instruction is afforded, and while the choice of tenet is pointed out by the constitution of our country, I will not say by a necessity which the spirit of dangerous innovation enforces, the greatest facility should be allowed to all desidents, to receive instruction according to their particular faith. Political considerations should have no weight whatever, and the better to guard against any undue influence of state prejudices, the managers should be selected equally from the two great contending parties.

Founded thus on principles of disinterestedness, of religious toleration and political equality, with men of high moral worth as managers, and publicity as a guarantee, the college could hardly fail of inspiring the utmost confidence in the wisdom and integrity of its founders. But, satisfactory as this may be to the public, it is not yet sufficient. The immediate practical object of the institution being to give, as far as is possible in a college, that kind of education which is essential to the engineering profession, its perfect

organization with this view is a *sine qua non:* and, in order to secure this, the following points seem to us essential.

First, the managers should be composed of three classes of men, scientific men, rich men, and those who are generally designated practical men, or men of business habits. These presided by an individual of high rank and influence, and who enjoys the public esteem, should compose the general managing and publicly responsible body.

Secondly, a director should be appointed, not a mere superintendent; and on the proper choice of this functionary a great deal of the success of the establishment must depend, for he should have the sole personal direction of the establishment of the college, its instruction and discipline, exercising authority under, and being responsible to, the council of management. With the laws and regulations of the establishment for his own guidance, his duty should be to enforce their observance by masters and pupils. His character should be unexceptionable, his habits those of order and punctuality; he should unite firmness with perfect amenity and gentlemanly bearing, be zealous in his exertions for the best interests of the college, and possess a perfect acquaintance with the whole working and capabilities of the system of education confided to his direction. It is by no means necessary that the director should be a proficient in the several sciences taught, indeed, it would be impossible to find any individual proficient in them all; it is sufficient if he know their several bearings and respective importance. He should understand the co-relation of all the parts, and so direct the particular efforts of each, that all may tend to one point. He should have discretionary power proportionate to the greatness of his responsibility; for to render responsible without giving authority, would be unjust, and to give authority without responsibility would be the height of imprudence. The director should, in fact, be the representative, the confidential delegate of the council in one sense, while he is in his person the executive of the whole concern.

Thirdly, the several professors and masters should be the very best that can be secured, and in their appointment, as indeed in that of every individual connected with the establishment, all favour and partiality, all private friendships and interests, should be discarded, and nothing but the most decided superiority over other competitors determine the choice.

So much for the *personnel*. The *matériel* of the establishment should be of the most ample description. The site of the college should be chosen with a view to perfect salubrity and respectability of neighbourhood, in the vicinity of the metropolis, near the river, and with extensive grounds. The building should be spacious, and should contain the following apartments:—five class-rooms, each with its adjoining amphitheatre, one large amphitheatre, one large hall, a library, a physical and a mineralogical cabinet, an extensive model-room and work shops; refectory, dormitories, chapel, infirmary, and bathing-house, with appropriate apartments for the resident officers and officials. The whole should be constructed in a style of simple elegance, and in the most substantial and solid manner, with the strictest regard to convenience, facility of communication throughout, and with particular attention to light, warming, and ventilation.

Of the course of study to be followed, many considerations are essential to its perfect arrangement. It is not enough to say such and such sciences must be taught, each must be considered in itself, and in reference to the rest, having also regard to the whole number of hours required in going through a complete course of five years. Thus, one study requires for proficiency in it less time, that is, fewer lessons, than another; one study requires to be followed up more closely than another, that is, with a less interval of time between the lessons; one study is more intimately connected with some other than with the rest, so that the lessons of the former are more efficient when they are made to follow close on the heels of that with which it is immediately connected. Some studies must be completed or greatly advanced before others can be begun; for some studies, the morning is the best time, for others, the middle of the day, and for others, again, the evening. The mind must be relaxed by a judicious admixture of the more abstruse and recondite studies with the lighter and easier. The first operation, therefore, is to class all the several studies according to their several considerations, and then to combine and arrange the whole in such a manner that the most perfect distribution shall result. Nor is this an easy task; fortunately, it has to a certain extent been effected by the ablest men of the continent for the Polytechnic, and other similar schools, after years of trial and experiment. Supposing then the distribution of particular studies effected, they are to be divided into classes, say five, of a year each; the first will of course be elementary, and the last of a recapitulatory nature.

Of the time absolutely devoted to study, be it observed that it is more advantageous to devote fewer hours to it each day and not to interrupt the course by long vacations, than to employ the greater part of the day, with long vacations of several weeks. Six hours a day for study, properly so called, are quite sufficient, with holidays in no case exceeding a fortnight. In some schools abroad three days at a time are the longest holidays allowed, but a day's recreation is frequently given, besides half-holidays each week and the Sundays; and this system is a good one. Six weeks vacation at one time of the year, a month at another, and a fortnight at a third, which is general in England, make up three months out of the year: certainly a very convenient, agreeable, and economical arrangement for schoolmasters and teachers, but a most prejudicial one for the progress of the pupils. Every one knows how little is done at school for a fortnight before and after the great holidays; how much is forgotten in the pleasurable indulgences of home, of what was learnt at school, and how irksome the discipline and occupations of the seminary after the liberty and amusements of the holidays. He knows little of human nature who does not know how much of our sufferings depend upon comparison and contrast, and, however lax the discipline of a school, however mild and indulgent the master, however light and easy the studies, they will always appear harsh and irksome by comparison with the delicious idleness of home, and the enjoyment of those indulgences to which, by prescriptive right, boys are entitled in holiday time. It may to many a fond mother appear hard and unnatural thus to keep boys from home for so long a time, but let it be remembered that not only is such a system calculated for their best interests, but that, after all, the sacrifice is only imaginary. Experience, where the plan of short holidays is followed, fully proves that the boys never think of holidays, and not being overburdened with dry study while at school, their days flow on cheerfully, and uncounted but by the desire of passing that final examination which is to end their temporary restraint. Besides, they can be at home for ten days every year, and those parents who live near enough may have them home one whole day in every week, and see them every day if they wish it. This, it may be urged, is all very well for the boys whose probation is at an end in five years, but are the masters to be perpetually confined to the drudgery of their vocation? To this we reply, that not one of them gives his whole time daily, but, in any case, let those who are content with the short holidays, be remunerated accordingly, and let those who require more relaxation have it on producing an unexceptionable substitute to perform their duties in their absence.

This subject of hours of study and holidays settled, we have to say a word on the mode of instructing, a most important object. Nothing can well be more preposterous than the slovenly method which prevails in our schools. The boys come in, take out their books, and are supposed to be occupying themselves with their respective tasks, whereas the greater number scribble on their slates, cut marks in their desks or draw upon them, play together, read novels, or crunch apples. The diligent and clever boys do the tasks of the idle or stupid for halfpence, or nuts, or some other consideration, and prompt their replies when called up. A question unanswered merely sends a boy a step or more down the class or back to his desk. One boy's negligence is excused, for reasons best known to the master, while another is punished. Exercises are corrected by the ushers without explanation, and incorrect sums sent back to be corrected, which is generally done by some cleverer boy. At length comes the examination week, and, if it have any thing like publicity, every question to be asked is known beforehand, and the replies learnt by heart, or prompted in an artful way by the presumed impartial examiner. "Is not Constantinople the capital of Turkey?" "Yes."—"Pray, of what religion are the Turks? you know, of course, that they are neither Christians, nor Jews, nor pagans." "They are Mahometans."—"You know, of course, that they are so called from Mahomet, the false prophet?" "Yes."—"Are not

the three angles of a triangle equal to two right angles?" "Yes." —"What then is half this sum equal to?" "One right angle." —"Very good, one right angle. Now, sir, how many degrees are contained in a right angle?" "90."—"Pray, sir, what queen succeeded immediately to Queen Mary?" "Queen Elizabeth." —"Quite right, sir. And who succeeded Queen Elizabeth, was it not one of the Stuart family?" "Yes."—"King James, I think, was it not?" "Yes, King James the 1st."—"Was Mary bigotted?" "Yes, she was a catholic?"—"Very right, sir, she was a bigotted catholic, and burnt the protestants." And so goes on the impartial and edifying examination. After which are produced fine specimens of penmanship, patched up by the writing master, drawings touched up by the drawing master, cyphering books nicely ruled with red ink. Perhaps theses are read, or a page of some French or German author, apparently opened at hazard, fluently translated; a speech spouted, a problem demonstrated, &c. But why go into the details of what every body knows. In a word, then, the school breaks up for the holidays, and after a few years, in which, perhaps, some Latin and bookkeeping may have been learnt, with a smattering of French, some daubs of drawing, some parts of the history of England and the names of the several European capitals got by heart, the young gentleman has finished his schooling. We speak not of Cambridge, where good mathematicians are formed; nor of Oxford, famed for its classical instruction; nor of King's College, where a better system maintains, and where instruction of every kind is given by the ablest professors; but we speak of our schools in general, those that are frequented by the large class of our youth not destined specially for the practice of law, physic, or divinity; of the schools, where young engineers receive whatever instruction they get before being apprenticed to the profession, and we say the plan is essentially bad and inefficient.

The mode of teaching which, in our opinion should be followed is this:—

The pupils assemble in the amphitheatres of their respective classes and without books, such as choose having slate and pencil or paper for making notes. The professor or master stationed at his large black board, chalk in hand, gives out the subject of the lesson, and proceeds with the operation, whether it be a sum, a problem to be solved, a theorem demonstrated, an algebraic equation to be worked out, a projection to be drawn, a plan to be constructed, or, in fact, any thing which may be explained by lines and figures. He explains every part of the process, goes over it again, and does his best to make it comprehensible to the eyes, ears, and understanding of his young audience. Observing, at the same time, but, without making any remark, any want of attention or improper conduct of the pupils. His hour concluded, he retires, and the pupils file off to their immediately contiguous class room, where the assistant, ***repetiteur***, or usher, accompanies them, or waits to receive them. Here the pupils, seated at their respective tables, work in silence upon the subject they have just had explained, and should anything have escaped them or not have been properly understood, the usher again explains and assists. By this means the pupils have not their attention immediately diverted to other objects, but by applying themselves directly to what is yet fresh in their minds, fix it there; the nail, so to say, is clinched as soon as driven.

It must be observed that the pupils should never be engaged more than three hours at a time, so that all studies which are susceptible of being taught in the way just described should be given at such time that two continuous hours may be devoted to them: for, if the last hour of the forenoon were devoted to the amphitheatre, and the first of the afternoon to the working out, the object would be missed by the dissipation of ideas in the intervening time.

Every branch of knowledge that requires it, and is susceptible of being taught by the above method, should be so taught; and, though all do not require the employment of two consecutive hours, as, for instance, languages, history, geography, drawing, &c., yet the tuition at the board in the amphitheatres should be employed whenever it is possible. Construction of all kinds should be taught at the board, but in the class-room; the master constructing with large and proper instruments upon the board, explaining every thing he does, while each pupil follows the process step by step on his paper at his table. In a word, every thing should be shown and explained, analyzed and recomposed. With such a system, if the pupils do not learn, the fault must be entirely their own. But it is important to ascertain their progress and ability; and for this purpose every pupil should be examined once a fortnight, either by the professor or master, in what he has been previously taught. This examination takes place at the board, no one knowing when he will be called up, or on what particular point he will be questioned. According to his answers the master puts a number to his name. No. 10 implies perfection, and inferior numbers proportionably less satisfactory answers. The master also indicates by numbers the general conduct and behaviour of the pupils in amphitheatre and class-hours. These lists of numbers are handed over to the director every month, under whose inspection they are registered in a book kept for the purpose. In addition to these particular examinations, a half-yearly examination should be made of a more extensive nature, and its results also noted. Towards the close of the scholastic year, the numbers are calculated according to a formula, which determines the eligibility of the pupil for passing into a higher class. It must be observed that the estimation of the proficiency of a pupil by the calculation of the numbers does not consist in merely taking a simple mean between them; but the studies are arranged in categories according to their importance, and a proportion established accordingly; for a low number in an important branch of study is of more value than a high one in some easy and less essential branch of the course. When it is determined what young men are competent to pass from one class to another, their public examination takes place, in order to prove such competency. On this occasion men of science should be invited, and, a printed synopsis being put into their hands of what each class has learnt, any person present may put any question to the pupils, such questions being limited of course to the extent and nature of the studies gone through. This examination is of necessity impartial, nor can the preceding examinations of the masters be otherwise, for they are made in presence of the boys; and as these can at any time see the list of numbers in the director's office, any partiality of the masters would be immediately detected by the pupils themselves, who hear the questions and answers, and who soon learn to judge of the value of the numbers. Besides, it would be the director's duty to be often present at the particular examinations, and see that all is conducted fairly. Lastly, partiality in the particular examinations would be of no avail, tested as the pupils' abilities are by the grand public examination.

Each class having its regular course, and the pupils of each class being taught in common, it is clear that no pupil can pass from one class into another but at the beginning of each scholastic year. Were he to come in at any other time, he would not understand what was going on, and the master could not retrograde the whole class to fetch up the new comer to its level. Neither can one pupil advance *faster* than another, that is, he cannot overleap him, for there again the master would have to leave the class behind to urge one forward. But if one cannot advance faster than another, he may advance *better*; he may always, by his diligence and assiduity, secure to himself the highest numbers, so as to be sure of passing yearly into a higher class, while the idle are compelled to pass a second year in the same class, if they fail in passing their examinations. Moreover, the quantum to be learnt is so apportioned to the time, that all the pupil's efforts are required to keep pace with the progress of the lessons.

Further, as the success of instruction depends greatly upon being perfectly grounded in its elements, no pupil should be admitted at once into any of the higher classes, unless he be found, upon a very strict examination, to understand as fully all that is taught in the lower classes as if he had studied in them; and, indeed, it would be well to discourage as much as possible the entry of all pupils but such as are destined to begin and go through the whole course in order, as it is for the education of the latter alone that the college should be held responsible. Pupils might or might not be admitted to follow certain branches of study exclusively, entering of course when the classes begin. But as all branches of study are separately taught at King's College, or elsewhere, such pupils as wish to obtain instruction in some particular object only should go there in preference to going to an establishment where every thing should be so linked that no portion can be complete without the rest; and where, though each branch of education is extensive, the whole

instruction should be given with a special regard to a particular object. Thus, for instance, a complete course of chemistry cannot be given, for this would require more time than can be allowed to it in an establishment where so many other things are to be taught. The chemical teacher should therefore limit his instructions first to the general elements of the science, and then to such application of these as are most useful to the engineer. The chemical changes which metals undergo in passing from the state of ore to that of the greatest purity, the chemical difference between iron and steel, are more necessary to be known to the engineer than the chemical changes of the blood. The latter are taught with propriety in the lecture-room of an hospital, or college for physicians, while the operative chemist, again, requires a course embracing all the generalities of the science applied to the preparation of drugs. The same kind of reasoning is applicable to every branch of study that should be taught in a college for civil engineers.

From what we have said, however, it must not be inferred that the course of education proposed for civil engineers is so exclusive as to fit those who follow it for no other profession; far from it, the course embraces all that is useful in a general education; and we make bold to affirm that, if properly conducted, it would be found more adequately to prepare a young man for any career save that of law, physic, and divinity, than any course yet given in this country.

We have now to speak of *practice*. Already have we said that experience in engineering can be acquired only at the works; there are nevertheless certain practical objects which may be taught while remaining at the college. Such are surveying and levelling, mineral boring, draining, modelling, casting and forging, turning, &c. For the two first, the pupils should be taken out at proper times, and taught to survey and level with different instruments, and according to different methods, to plot, to profile, and calculate areas and distances. Mineral boring may be practised in the grounds of the establishment, and conducted gratuitously in any places in the neighbourhood, where the operation may be required. Draining can be taught only on a small scale while the pupils are at college, by perambulatory exercises, in company with an explaining master. The operations of casting, forging, turning, &c., may be performed, in the small way, on the premises, so as to give an idea of these processes, and the use of tools is well learnt by making the pupils construct models. But the chief practical lessons that can be given at college are by the periodical examination and explanation of public works on the works themselves, by some competent person. A mode which, by the way, presupposes permission granted to that effect. Very useful instruction may be given by experiments on the strength of materials, for which purpose the requisite instruments should be furnished, and the use of them gratuitously granted, for experiments to be made on the spot, by any persons wishing to avail themselves of this advantage; the pupils of the higher classes being always present on these occasions, and having every thing properly explained to them. The practice of various kinds of roadmaking and paving may also be carried on at the grounds; as also centering, arching, &c.; the latter objects by working models. Add to this, that the collections of the establishment should contain specimens of every material used in engineering; as all kinds of bricks, tiles, slates, stones, limes, sands, &c., &c., with the name, specific gravity, quality, locality, price at the place of production, &c., of each, distinctly labelled, and their several advantages and defects pointed out. The processes of brick-making should be properly explained at the principal fields in the neighbourhood; and, in short, every thing of a practical nature that can be taught while the pupils are still at college, should be so taught; and this may easily be done, with much benefit to the young men, while it acts as a kind of recreation from close study.

But all this is not engineering experience, which, as we have repeatedly said, must be acquired at the works themselves, and the best means of effectually accomplishing this, in conjunction with the college course, remains yet to be devised.

We would venture to suggest that the principal civil engineers of the country be invited to aid and support so important an object as efficient engineering education, by taking such young men as have passed through their college course with success, for a couple of years, without premium and without salary, engaging to employ or recommend them at the expiration of that time, if their conduct shall have given satisfaction. A portion, say one quarter of this time, or six months, to be devoted to the learning of office duty, and the remainder to be employed at the works. By this arrangement, the young men, supposing them to enter the college at fourteen, would be certain of employ at twenty-one, and would begin their career with every possible advantage; while the engineers themselves would be amply remunerated for the, to them, trifling pecuniary loss of what they now get by apprentices, by the advantages derived from the ability and instruction of the young men under them.

Nay, more, the engineers, joining heart and hand in supporting the college, might reap a further benefit by having their drawings executed gratis at the college, their models constructed there, &c.

One important point still remains to be noticed. The highest scientific talent of the country, the Herschels, the Faradays, the Wheatstons, &c., should be solicited to take an active part as managers, visitors, or otherwise, in the affairs of the college for civil engineers. Be it remembered that in France the very first men of the country deemed it an honour to be connected with the Polytechnic school, and surely nothing but honour can result to our own men of science, by lending the support of their great names, influence, and talents, to an establishment eminently calculated to benefit their country.

Much has been said of the opposition made by the profession to any change in the present system, and such unworthy conduct may, perhaps, be imputable to some; but it would be to attribute to a highly respectable class of men the vilest of sordid views, the greatest imbecility and want of patriotism, to imagine, for a moment, that they would not cheerfully, as a body, and if properly applied to, lend their utmost aid and support to any plan, having for its object to furnish them with efficient assistants, instead of the ignoramuses to whom they are obliged to confide a portion of their reputation, and calculated to raise the already high character of their profession to a still more exalted rank. Much has also been said of their jealousy. Of what, we would ask, have they to be jealous? Will the great engineers of the day have one important work the less confided to them because a class of men shall be forming, competent, in time, to walk in their footsteps, and extend the glory of their country? Will they not, on the contrary, by aiding in so noble an undertaking, have a fresh claim to the admiration and gratitude of their already admiring countrymen? Indeed, they cannot but see that their own best interests are concerned in the establishment of a system of engineering education, which will henceforth exclude from exercising the noble profession of civil engineering, any of those bunglers that now bring shame and discredit upon it.

Our task is now concluded, and we find that, although we have given but a very imperfect sketch of our subject, it has unavoidably been extended to a greater length than we originally intended; but the subject is so vast and important that a volume might be written upon it. We have rapidly traced out the multifarious labours of the civil engineer, we have endeavoured to show what very extensive knowledge he should have, how inadequate the present system is for the attainment of that knowledge, and that a special course of instruction is necessary. We have pointed out what that course should, in our humble opinion, be; how a college for civil engineers should be organized, and in what way instruction in it should be given; and, finally, that the cordial co-operation of the principal civil engineers and scientific men of the country is most desirable, and expressed our conviction that, if properly sought, it would not be withheld. It now only remains for us to say; that, after endeavouring with untiring zeal for fifteen months to effect the establishment of an institution upon the plan herein contained, we have been unable to succeed. A college is, however, established, and, if it do not prosper, it will certainly not be for want of the most zealous and conscientious exertions of some of its noble patrons, who, with an industry and liberality beyond all praise, are doing their best for its success.

If any thing in these pages, which, after all, contain but a brief *exposé* of what the Council of the College for Civil Engineers already possessed in greater detail, may be found useful in carrying out their views, we shall be unfeignedly glad. Our present object, however, as stated in the beginning, is to prevent all erroneous conception as to the plan of education we had proposed, by thus laying it before the public, that they may judge for themselves. A better plan may certainly be devised by abler individuals, but we do not hear that any thing better is doing, or has yet been done.

ON THE NEW ROYAL EXCHANGE.

SECOND ARTICLE.

After a succession of delays and difficulties almost unprecedented, the question as to a design for the intended Royal Exchange is at length finally decided; we, therefore, return to the notice of this subject in conformity with the promise given in our seventh number. The engraving which accompanies the present article exhibits the interior of the area for the meeting of the merchants, as proposed by Mr. Tite. From this the style of its architectural features will be readily apprehended, and it will be observed also that the distinguishing characteristic of the area of the old Exchange, as being an open court, is retained in the present composition, in accordance with the original instructions issued by the Gresham committee for the direction of the competing architects. The instruction upon this point, as well as upon others, was framed, as we are informed, in compliance with the general opinion of the merchants and bankers of London. With submission, however, we are strongly inclined to believe that the merchants and the Gresham committee might have left this matter, with benefit, to the discretion of the architects offering designs, with whom it would have remained to demonstrate the advantage or defects of either mode of construction, whether open or covered.

It is worthy of remark that the Bourse at Paris, that at St. Petersburgh, the Exchanges of Dublin and Glasgow, and almost all modern structures erected for a similar purpose, are, we believe, roofed in; one advantage of which is, that the whole of the area is available, let the weather be as unfavourable as it may; consequently, the same superficial extent canaccommodate a far greater number of persons than where it is only partially sheltered, and where a considerable portion must frequently be altogether uset less, as far as actual serviceableness is concerned, therefore such an arrangement is to be approved of only where what is thus sacrificed, with regard to mere convenience and utility, is amply atoned for by what is gained as to architectural character and effect.

We do not deny that a *cortile*, whether surrounded by columns or by arches, and whether partially so or entirely, is favourable to scenic effect and display; and, farther, admits of very great variety as to plan and design; this being sufficiently testified by examples in Italian buildings, where cortiles frequently constitute the most striking and beautiful parts, generally picturesque and piquant, though not always unexceptionable in design. But, then, it does not exactly follow that because a cortile is beautiful as such, it is eligible for a purpose requiring more than a sheltered corridor around the open part; for, although that kind of shelter is sufficient for a place of *passage* to and fro, it certainly does not seem to be so, or to be altogether in character, for one intended for the assemblage of a concourse of persons, not on particular occasions, when, in case of the weather proving unfavourable, the company may be protected from it by awnings provided for the emergency, but daily, throughout all seasons of the year. When a place of the kind already exists, it may conveniently and properly enough be applied just as it is to the purpose of an Exchange; its inconvenience may, then, be readily put up with as unavoidable, at least, to be got rid of only by extensive alteration. There is no qualifying circumstance, however, to reconcile us to a defect studiously adopted for the nonce, voluntarily and with premeditation, to the exclusion not only of positive convenience, but likewise of originality of design. Either our climate is most unjustly reproached, not only by foreigners, but by ourselves, or it ought at once to have banished all idea of rebuilding the Royal Exchange upon the plan of the former one, as regards that very principal part of it where the merchants will daily assemble, and to which all the rest is to be considered as merely supplementary.

Be it any improvement or not, all our lately built markets are floored with flagstone pavements, and covered in from the weather, shaded from the burning sun of summer, as well as sheltered from rain and snow in winter; nor do we believe that either the occupiers of them, or their customers, at all regret the change which has taken place. Nevertheless, with instances of that kind before their eyes, not in the Metropolis alone, but at Liverpool, Newcastle, and other places, the merchants and commercialists of London have decided that they are to meet for business as heretofore, within an area only partially and imperfectly protected from the weather, for even beneath the colonnades, they must be more or less exposed to wind and rain, and be inconvenienced by the throng of persons; whereas, by converting the central space into the part more particularly appropriated to the transaction of business, the sides, which might still be separated from it by colonnades, would be left free for persons passing in or out, without interruption to those engaged in business.

There may possibly be contrary reasons for not adopting a mode of building securing the advantages here pointed out by us; but they have not been brought forward by others, nor can we divine what they can be. Hardly can it be objected that any plan of the kind would destroy all peculiarity of character, by converting the Exchange itself into merely a spacious hall, lighted from above; which, however it might be decorated, would, in its general effect, resemble any other public apartment of the same dimensions; because although it would no longer be a cortile — an open space enclosed by façades of external architecture, it might be kept altogether different from any thing we are accustomed to in interior architecture, and appropriately rendered *sui generis*. Hungerford Market may be cited as an instance, pointing out sufficiently well for our purpose how a distinct character may be obtained: inasmuch as it is covered in from the sky, it may be called a hall or interior, but it does not carry with it the idea of one, — certainly not of any room within a building; for, except the being covered by a roof, it has scarcely anything whatever expressive of one.

We doubt we shall be met by the exclamation, "Would you then really think of adopting anything from a market, for such a structure as a Royal Exchange?" In return to which we reply, that we would adopt an idea from a pigstye, even though it were for a royal drawing-room; provided we could turn it to account, in the way either of convenience or of beauty. Unfortunately, however, such kind of plagiarism, though in itself the least culpable, or rather the only laudable species of it, is precisely that which is least understood, and least of all practised. Were we to say that Hungerford Market (a covered area of about 160 feet by 80), offers, both in its dimensions and in its plan, so suitable a model for the purpose that nothing more is necessary than to copy it exactly as it is for the nucleus of the intended Royal Exchange, merely adding to it what else is wanted for farther accommodation, our taste might justly be called in question, although as far as utility and convenience alone are concerned, our judgment would be tolerably safe from imputation. Yet although homely enough as regards style, and, owing to the purposes for which it is employed, partaking more of the picturesque, than of any other kind of beauty, that structure offers not a little which is applicable to the case of the Exchange. The division into three walks or aisles of equal breadth, the centre one of which is lighted by a clerestory of unglazed arched openings, above the larger arches below, the open framing of the roof, similar to those of ancient basilicas (from which, indeed, the general idea of the design is borrowed), and some other parts, present features of which very much might be made, and susceptible of any degree of decoration; to say nothing of the combinations and richness of *polystyle* effect, to be obtained by introducing additional ranges of columns. The idea of covering in the building once adopted, there would be almost a perplexity of choice as to the particular arrangement to be fixed upon. Among others, we should imagine that that of a circular peristyle for the centre, enclosed within a square one, so as to have two walks around the rotunda part, would have a pleasing effect; or else there might be a second circle of columns, in which case the angles or spandrels of the square forming the general shell of this part of the edifice might serve as *exhedræ*, or alcoves, in one or more of which there might, if desirable, be entrances to staircases, leading to rooms and offices on the upper floor. By so dividing the plan, less height becomes requisite than if the whole were thrown together, so as to form a single large hall; while, as what would else form the upper part of the sides of an open court, would, by roofing in the area of the Exchange, be concealed from view, they might be left with mere plain walls, and windows made in them wherever required, without any regard to regularity. But though we have ventured to throw out the idea of a circular area in the centre of the plan, we would not have it covered by the kind of dome generally employed for the purpose,—as in the Pantheon at Rome, but surmount the columns by arches, and carry up a wall or

tambour above them, to serve as a clerestory, with openings for the admission of light and air, showing, both in that part, and all the rest, the beams and framework of a metal roof, which might be rendered as decorative as might be desired, both as to design and to colouring. Or, if it be insisted upon that our Exchange be *hypæthral*, it might still be so, by merely leaving the central compartment of the plan unroofed, and finishing it accordingly, whereby the covered would bear a much greater proportion to the uncovered space.

It behoves us, however, to desist from these somewhat extraneous, and certainly gratuitous, adumbrations of our own ideas — others may call them fancies — in which we are now indulging; and which, let them be received as they may, will at least serve to show that the question as to the eligibility of an open or covered area might have been more strongly brought under the consideration of those who were invited to send in designs, or rather that such questions should have been *pro-and-conn'd*, in the very first instance of all, by the merchants themselves, who, it may be presumed, are sufficiently competent to judge of the convenience or inconvenience attending the two different modes. Probably it did not occur to any one of them that the advantages of both might be secured, and that it would be possible to shelter the whole area from rain, and yet leave openings, arches, or otherwise, all around it in the upper part, for the admission and free circulation of air.*

Not the smallest difficulty of all for the architect to contend with is the extreme awkwardness of the site; and that not merely as regards the shape of the building itself, but its position with respect to others, and its locality generally. Most assuredly, the Bank will not be at all benefitted by being brought into proximity with a lofty structure of a single order, placed midway before it. Nor will the general effect, as to grouping, we apprehend, be in any degree improved, by entirely clearing away the present mass of what are called the "Bank Buildings," so as to leave there an open triangular space, which may be decorated, but cannot be filled up, by the equestrian Wellington statue; and will therefore only increase the number of gaps, which, with points and angles, must produce a degree of irregularity little short of architectural confusion. Notwithstanding this, it was resolved that the line of buildings facing and running parallel to the south front of the Bank should be cleared away; therefore, so much ground will, in our opinion, be not only needlessly, but injudiciously sacrificed, because no other effect than an awkward and disagreeable one can thereby be obtained; for, even supposing that the open space so formed should afterwards be extended, by removing the Globe Insurance Office, and the adjacent houses as far as the line of the west front of the Exchange, no regularity would be produced by it, except the whole locality could be re-modelled. No one seems to have asked, whether, under all the circumstances of the case, it would not be more advisable to retain the ground westward of the Exchange, for building upon again, and to erect there a distinct architectural mass, to contain some of the shops, whose former tenants it has been pledged to reinstate, and whose rental is made so important a consideration; and to provide on the floor above them for such of those offices, &c., as are not immediately connected with the business of the Exchange itself. An advantage attending the keeping the shops separate from the Exchange is, that the plan of the latter would bear a little abridgment at its narrowest part, so as to obtain somewhat greater width for the west façade, and sufficient space in front of it for viewing it advantageously; yet the merchant's area might be larger and more commodious than it can now be rendered, when provision must be made for so many shops around it.

Most undoubtedly, by leaving an open space in front of it, the west end of the Exchange will be visible from the Poultry, which seems to us to be the only advantage to be gained, and even that a very questionable one in itself. So viewed, that façade will just serve to make all the other buildings in its vicinity appear small by comparison, without producing any very remarkable effect in itself. The spectator will be prepared for it so long before he comes up to it, that when he does so it will strike him less than it would do were it to present itself at first to the eye at no greater distance than what is necessary for displaying it advantageously. As far as architectural effect is concerned, it is, perhaps, the lesser error of the two, when a building is seen in a somewhat confined situation, than the contrary; because then it, at all events, fills up the picture, and impresses us with the idea of magnitude. At least, we cannot help regarding it to be an error in the contrary extreme to expose a building as much as possible, because some have been put in such confined and choked up situations, that they can hardly be seen at all. The reverse of wrong is not always right; neither is very much gained by exchanging a disadvantage of one kind for a disadvantage of another kind; and disadvantage surely it is to present a building so as to cause it, when first seen, to look diminutive and insignificant in the general view, unless, indeed, it happens to be so peculiar and picturesque in outline as to be especially calculated for a distant object. To be convinced of this we need travel no farther than Trafalgar-square, where, owing both to the distance from which they are seen, and the open space of ground, the buildings look comparatively low and deficient in dignity, and produce no effect as a whole. As seen from Parliament-street, the National Gallery is but an insipid object, scarcely better than so much dead wall of the same extent would be; whereas, could it be seen from no direction in front farther off than from midway of the square, it would make a much more dignified appearance than it does at present.

Entertaining such notions,—be they either well or ill-founded ones, we must confess that, other circumstances taken into account, we are more inclined to deprecate than to advocate the intention of laying the west end of the Exchange entirely open, so as to form a distant architectural object, when the same purpose may be more profitably accomplished by building upon the ground now designed to be left a vacant gap, and there erecting, in plainer but elegant style, a range of building whose western point might be rendered sufficiently striking in the view from the Poultry. By this means, so far from any thing being lost, an additional building for shops would be gained, and an offensive hiatus avoided; while the west front of the Exchange — which, although it will be the smallest, is considered the chief façade—might still display itself highly advantageously, and would hardly prove the less striking because not anticipated by a distant prospect of it.

As regards public convenience nothing would be lost, or a positive advantage gained; for, unless the space now purposed to be left quite clear from buildings be properly fenced in from carriages, yet so as to allow foot passengers to cross it, such a thronged point of thoroughfare, at the confluence of so many streets, will prove a very dangerous spot — one where lives and limbs will be continually perilled.

Few, if any, of the points on which we have thus far dwelt appear to have been canvassed in that stage of the business when deliberation upon them might have aided beneficially in furnishing the competitors with more determinate data to work upon than mere instructions as to accommodation, and rental from shops and other lettings. Very far, indeed, are we from desiring that architects should be so tied down upon such occasions to a minute programme as to be thereby fettered, and prevented from following their own ideas; but they should always be furnished with sufficient data for their guidance as to all material points, and for their caution likewise, in order that they may understand tolerably well beforehand, not only what is likely to be approved of, but also what is likely to be objected to. It is true, where almost all, except a few indispensable particulars, is left entirely vague, an architect cannot very well complain of being restricted; but then he is thwarted by being in utter doubt and perplexity as to much which he must settle for himself as well as he can, having no farther clue of any kind by which he can shape his course. Even if left entirely to follow their own respective taste as to style, it would not, perhaps, have been amiss had the competitors been advised to aim more particularly at character and expression,* and to keep up consistency of design in the exterior and inner area.

* Mr. Cockerell seems to fancy that the gigantic cove he introduced into his cortile would have the effect of combining both advantages, and prove a successful middle course between a covered and an uncovered area; whereas we cannot help thinking that, while it would have been too much of an architectural *monstrosity* in itself, and would have suggested the idea of there having been a ceiling or lantern which had fallen in, and left the area *unroofed*, it would have united the disadvantages of both, being so contrived as to exclude sunshine, yet admit rain.

In regard to an Exchange with a covered area, we may observe that we have already one instance in the CORN EXCHANGE, Mark Lane, the old part of which, as recently altered with a glazed cove and ceiling, is fully protected from the weather, but has also openings for the admission of air.

* Apropos to this, we cannot resist from here quoting what Victor Hugo says

We might greatly extend our observations, if only by entering into the question we have just now hinted at; *yet as all that we have thus far said belongs only collaterally to our professed subject*, and may, therefore, be considered enormously lengthy, we shall not pursue those general comments any farther, but notice the design which has at length been fixed upon for the new Royal Exchange. The circumstances of the last competition must be tolerably well known to our readers, therefore we may be excused from touching upon them, more especially as we could not do so without inquiring how far the original competitors—the authors, at least, of the approved, though not accepted, designs—were fairly or unfairly treated in not being allowed to enter the lists afresh. If injustice has been shown towards them, no imputation on that account attaches itself to the successful competitor, either in his professional character or otherwise.

The perspective view in No. VII. shows the western end of the Exchange, from a much nearer point, however, than the Poultry, so as to confine the eye to the principal building, and exclude that confused mass of architectural objects which will crowd the promised picture of it from that spot. Yet, although too great to afford more than a general idea of the composition, the distance here selected is not sufficient to allow the tower at the eastern end of the building, lofty as it is, to be seen, which may be thought a cogent reason wherefore the structure should be viewed as far off westward as possible; whereas that very circumstance only confirms us in our former opinion, because as the tower will be visible, and by announcing the edifice to which it belongs, will rather excite than allay curiosity, all the less occasion is there for exposing the west end so long before it is approached.

Like several of the first designs, this also has a portico for its west façade—a simple prostyle, octostyle in front, and projecting only one intercolumn, of a plain Corinthian order, which is continued in pilasters along all the other fronts. As being upon a more imposing scale than any other example in the metropolis (for the height of the columns will be 41 feet, and that from the ground to the summit of the pediment 74), this will certainly prove, so far, superior to them. Still, when we consider that its real magnitude will be rendered less striking by its being first seen from a great distance and then gradually approached, we become more confirmed than ever in the opinion that it will be most unadvisable to expose it in the manner proposed. It appears to us that only a single *pro* has been looked to, while none of the *cons* have obtained any *con*-sideration.

With reference to the portico itself we must be allowed to protest against the excessive height of the pediment, whose tympanum exhibits only a barren surface which evidently requires to have sculpture of some sort introduced into it, if only partially, that is, for some distance on each side the centre of it. If sculpture cannot be afforded, we would recommend that the pediment should, at all events, be reduced in height, as that would cause it to appear less ponderous.

Judged by mere precedent and rule, its proportions are perfectly orthodox, for its pitch is, we believe, not quite so great as that of the Pantheon at Rome; and as the style here adopted is Italo-Roman, it may be argued that such proportions ought of course to be followed, otherwise they will approach too much towards those observed in Grecian architecture. Such argument, however, does not by any means reconcile us to what we feel to be a deformity in itself, and one of those defects in Roman architecture which ought to be avoided, at any rate mitigated as far as possible, instead of being punctiliously imitated. And is it not sheer punctilio and architectural prudery after all, to be so pertinaciously exact and scrupulous as to such matters, at the very same time that great freedoms are taken as to others? If the addition of Italian forms and inventions do not derogate from the dignity of the purity of Roman architecture, we really do not understand how some modifications of Roman borrowed from Grecian architecture can prove injurious to the former, or tend to destroy its real character by merely correcting its faults; we do not understand, we repeat, why such should be the case, and we farther very much question whether any one else can explain it to us. The style here adopted is evidently a compound one, as witness the Venetian windows within the portico itself, without our referring to many features and decorations in the other elevations; therefore it would still be but compound, were something to be borrowed for it from Grecian as well as Italian precedents, of course with the proviso that the adoption of it would conduce to beauty, without interfering with the general character.

As soon, however, as we enter the portico,—and for convenience sake we may be allowed to describe the design as if actually executed,—we at once perceive, if not exactly the motive, for it may perhaps be as much a consequence as a cause, what could not be done were the pediment of much lower pitch, since instead of being flat throughout, the ceiling is arched for the extent of three intercolumns in front, which division of the portico recedes within the building, making it there 32 feet in depth; by which means great variety as to perspective as well as depth of shadow is obtained; and though it projects forward only one intercolumn, this portico does not look, like so many others, to be merely a range of columns stuck up in front of a building, and scarcely affording any shelter or standing room within. The effect of this central avenue is besides greatly enhanced by its being continued so as to afford a vista into the inner area or cortile; and in advancing up it we obtain a view of the campanile or tower rising over the building at the opposite end of the court. But these are merits which cannot be made palpable by any general or any single view of the edifice, as they reveal themselves only by degrees, and not till we have actually entered the portico; although they are of such kind as may at once be understood from plans and sections. Consequently, the chief value and beauty of this part of the design are entirely lost at a distance; on which account we think it would be in every respect more advantageous to reserve it for view when we arrive at a suitable distance: Q. E. D.

Having begun to conduct the reader through the portico into the cortile, we may as well proceed to describe the last before we speak of the other fronts of the exterior. The lower part is surrounded by a peristyle of the Roman Doric order, forming seven intercolumns on each side, and three at each end; and having at each angle a pier whose four faces form as many projecting pilasters, and which is grouped with the extreme pillars of the colonnades abutting against it. Above this first order is an Ionic one in half columns filled in with arched windows inserted in larger arches (whose key-stones have pendent festoons), and decorated with smaller columns, panels, and other ornaments.

It is not however yet decided, we believe, whether there are to be windows, or these openings be converted into a series of niches (twenty in all) around the upper part of the court, for the reception of the statues of our English sovereigns; which may very easily be done as the rooms behind have windows on their opposite sides, and can have additional light obtained for them through their ceilings.

The proportions of the cortile are a double square in the plan, the measurements of the uncovered space being 114 feet by 57, while the height of the building enclosing it is 65 feet. This excess of height, as compared with breadth, causes the court to appear narrower and more confined than would be the case were the relative proportions reversed, or else the height decreased so as to give the present difference between them to the breadth. In fact, the court will be narrower and loftier than that of the old Exchange,—not so wide, we believe, by about 50 feet, yet nearly 20 feet higher. We ourselves do not object to the proportions now adopted, considering them to be more conducive to architectural effect; at the same time, we are of opinion that unless greater height could have been afforded to the lower colonnade, it would have been more advisable to reduce that of the story above it, at least towards the court, even though the doing so might have prevented the introduction of a second order. Or supposing this could not be so lowered as to make any material difference of effect,

of the Bourse, for, although we do not think very highly of him as an architectural critic, his remarks go towards pointing out incongruities that ought to be shunned, and more especially that absence of decided character which is not the least fault of all.

"Quant au Palais de la Bourse, qui est Grec par sa colonnade, Romain par le plein-cintre de ses portes et fenêtres, de la renaissance par sa grande voute surbaissée, c'est indubitablement un monument très-correct, et très-pur: la preuve, c'est qu'il est couronné d'un attique comme on n'en voyait pas à Athènes, belle ligne droite, gracieusement coupée çà et là par des tuyaux de poële. Ajoutons que s'il est de règle que l'architecture d'un édifice soit adaptée à sa destination de tel façon que *cette destination se dénonse d'elle-même au seul aspect de l'edifice*, on ne sauvait trop s'emerveiller d'un monument qui peut être indifferement un palais de roi, une chambre de communes, un hôtel-de-ville, un collège, un manége, une académie, un entrepot, un tribunal, un musée, une caserne, un sépulchre, un temple, un théâtre:—en attendant, c'est une *Bourse*."

the other alternative would be to increase the number of columns, and thereby reduce the distances between them; for at present we think the intercolumniations too wide and the entablature weak, even had it to support nothing above it,—much more so then when it has to support a second order filled in with solid walls.

In one respect, the new quadrangle entirely meets our approbation, namely, in the very great depth of the surrounding ambulatory within the colonnades, which is such as really to afford shelter, and to render it very commodious for its purpose, the breadth being not less than 28 feet, which is seldom exceeded even in spacious galleries, and which is, we believe, nearly double what it was in the old building. These colonnades may therefore be, in fact, described such as galleries, with this difference, that, instead of being enclosed and lighted by windows, they are entirely open on their sides towards the court, and so far the greater part of the entire area may be said to be actually under cover, although that which defines itself to the eye as the court, properly so speaking, is not. We are not prepared to say what may have been the width given to the sheltered walk around the open area, in any of the other designs, but in most of them we should take it to be very much less than what we find it to be in Mr. Tite's. In some, indeed, the colonnades in this part of the building appeared to be very shallow, so that they would have been found neither sufficiently screened from the weather, nor at all adapted to receive a throng of persons meeting together to transact business, although they would have been suitable enough as mere corridors, where only a few persons at a time are occasionally passing. Of course, greater spaciousness was obtained for the court itself, but then it was by too great a sacrifice in regard to utility and convenience, the open area being in bad weather altogether useless, and not at all agreeable at such seasons, except upon the Lucretian principle of "*suave mari magno*," &c.

It must be acknowledged, however, that advantageous as it is in itself, this amplitude of breadth causes the ambulatories to appear low for want of corresponding height, which height, we conceive, might best be given by somewhat shortening the columns, and placing them immediately on the floor, and making arches to spring from the capitals; and, although it may sound oddly to talk of shortening and lowering the columns, in order to increase the height of the ambulatory, unless that were done, the addition of arches of such span would probably occasion more than could well be afforded; or, should this be objected to, as requiring not merely a modification of the present design of the cortile, but that it should be re-modelled entirely, we would suggest that it would be some improvement if the columns were doubled, that is, were another column put behind each of those in front; this would contribute very materially to give the appearance of greater height within, and of more efficient shelter also, by counteracting the excessive width of the intercolumns; for although it would cause no difference whatever in a geometrical representation of the colonnades, it would greatly alter their perspective effect, because the inner or outer columns, according as they were viewed either from the court or the ambulatory, would be seen together, consequently the intervals, or intercolumns, be more filled up to the eye. Another advantage would be, that columns so paired, and therefore not requiring coupled columns in the order above them, would be more agreeable, inasmuch as they would afford the appearance of adequate support to the upper and more solid part of the elevations surrounding the open space, whereas, at present, that superstructure looks too heavy for the colonnade, more especially when the very great depth of the latter is taken into consideration. There is, besides, another circumstance—solecism, some would call it—which would thus be rendered less objectionable, and which is, that a slight break is made in the entablature of the open colonnades above every column. This has evidently been done with the view of obtaining a certain effect of lightness and loftiness by means of vertical lines continued through both orders, so as to reduce the width of the compartments into which the entire elevation is divided, to those suited for the intercolumns of a single lofty order. Be that as it may, by interrupting the horizontal line of the entablature, and suggesting to the eye that the architrave is not carried from column to column, but that the portion of it immediately over each column is the end of a transverse architrave or beam, extending from back to front,—this circumstance in the design by no means adds to the expression of strength, and, therefore, seems to call for indication of farther support, which might be supplied as we have ventured to suggest; for, although the mode we have pointed out would make no difference as regards the apparent want of bearing for the architraves over the intercolumns, it would both cause those intervals to appear less wide, and would add to the idea of strength generally.

There are four entrances into the Exchange area, viz., one in the centre of each side; but we think that those on the longer ones (the north and south,) might either be dispensed with, or else removed to the north-east and south-east angles, whereby the two principal walks would be kept free from the interruption otherwise occasioned by persons continually passing in and out, owing to which each of those walks will become in a manner divided into two, from the centre of the north and south sides. In our opinion, the entrances at the east and west ends would be quite sufficient, and the space now given up to the other two might very advantageously be given up to shops, the doing which would not at all disturb the plan, or affect the external elevations. Yet, should that be objected to, and it be considered more desirable, if not indispensably necessary, to have approaches from the street on the north and south sides, the inconvenience above pointed out would be greatly obviated by placing those entrances within an additional space or recess separated from the ambulatory itself (by piers or columns, as the case might be), and of such width as to allow persons to turn off right and left, instead of being obliged to go immediately into the middle of the walk. By this means, something, too, would be gained in regard to architectural effect, although it must also be acknowledged that something would be curtailed from the shops immediately adjoining those entrances, as space required for the recessed parts must be taken from their depth as well as from that of the entrance passages. Yet about ten feet, or even less, would be sufficient, and recesses or *exhedræ* of that depth would render those points of entrance into the Exchange greatly more commodious, both in appearance and in reality. If we have been somewhat minute—perhaps tediously prolix, in our remarks upon this part of the building, let them be whatever they may in themselves—judicious, or the contrary, they cannot very well be considered as altogether ill timed, because we may hope that many of these details are not yet definitively settled, therefore, should nothing that we have said furnish an idea worth being acted upon, our objections and hints may nevertheless, in the present stage of the proceedings, prove serviceable by leading to a mature consideration of them.

Our notice of the remaining external elevations will be more brief, they being all nearly similar in design as well as character, and differing from each other only in a few particulars. The north and south façades, indeed, may be said to be perfectly alike, the only point wherein they do not agree being that the former is divided into fifteen compartments, the latter into thirteen; the lower parts of which are filled up between the pilasters, by as many large rusticated arches,—the centre one for the entrance into the Exchange, while the others are occupied by the shop fronts, and the entresols above them. The upper floor presents a series of large segmental-headed windows (thirteen and fifteen respectively), with bold kneed architraves, console keystones, and foliage. Each elevation is crowned by a balustrade, except over the three middle intercolumns, where the centre of the composition is marked by an attic, rising somewhat higher, and decorated with panels, &c. The lower part is also distinguished from the rest by the keystones of the arches being enriched, and other embellishments added. The subjects of the escutcheons on the keystones, need not be here mentioned, as both they and the other ornamental sculptures are particularized in Mr. Tite's own explanation of his design for the Exchange, (see No. V. of this Journal) to which paper we may here refer generally for information, in regard to a variety of circumstances that we have passed over, as neither requiring additional explanation, nor calling for any comment or remark on our part. We, therefore, now proceed with our notice of those features in the design which suggest matter for such observation.

The unbroken lines of these elevations may be, in some degree, judged of, by the Cornhill front, which was shown in our perspective view in No. VII., although so foreshortened or obliquely, as not to allow more than such continuity to be made out. The shops are very judiciously managed, so as not at all to cut up the design, or become obtrusive in it; and, as they are uniform in design, it is to be hoped that precautions will be taken to keep them so, by restrictive

clauses in the leases prohibiting the occupiers from putting up any kind of sign-board, and from painting their names in whatever way they please, limiting the latter to some panel or tablet in the architecture, especially provided for that purpose, immediately over every shop door. There should likewise be similar restrictions to ensure uniformity of colour in the doors, shutters, &c.; otherwise, it is to be feared, rivalry, and the desire of distinction, would soon prevail over good taste, and the shop fronts exhibit as motley an appearance as those in Regent Street, to the very serious injury of the general effect of the building. But, if strict uniformity be enforced, the shop fronts will not detract very much from the rest of the architecture; and, although it would be more satisfactory to us were there no occasion for them, we admit they will, in some degree, contribute to give character, by marking out the edifice distinctly enough as one appropriated to business, and so far preventing that vagueness of expression with which Victor Hugo, as we have seen, so severely reproaches the Bourse at Paris.

The north-east and south-east corner of the plan are curved off to such an extent as to admit of three arches, with shops in each of them, whereby the acute angle which the longer façades would else make with the east front is not only got rid off, but the obliquity of the sides rendered hardly noticeable. The last-mentioned façade resembles the north and south ones, except that a tower here rises in the centre by stages, ornamented with columns, to the height of 170 feet, measuring from the ground to the top of the vane. The reasons for placing the tower at this end of the building are explained, and, we think, very satisfactorily, by Mr. Tite himself, nor have we anything to allege against its position; we may, however, as Mr. Tite has not adverted to it himself, mention one circumstance greatly in favour of the situation chosen for it, which is, that it presents a striking architectural feature on entering the Exchange through the portico, being directly in a line with it; whereas, were it erected as before, over the centre of the Cornhill front, its effect, as viewed from the inner area, would be decidedly bad and unarchitectural, as it would then be on one of the longer sides, and thereby not only destroy symmetry of arrangement, but make the area itself look narrower than it is. Something of the kind of irregularity just alluded was to be seen in the old Exchange, although it was not there so perceptible as to amount to a defect, because the quadrangle approached more nearly to a square, there being seven arches on each of the longer, and five on each of the shorter sides; whereas, here there is more of an avenue-like vista from end to end. As far as regards design alone, the tower might have been placed indifferently at either end; but there is one—and that no inconsiderable advantage, attending its being placed at the east instead of the west end of the quadrangle, which is, that instead of being itself in shade, and shadowing the court, the sun will fall full upon it after noon-day, the time when persons assemble on change; consequently, it will be an important object, one that will give much brilliancy and much scenic and picturesque effect to the architecture of the cortile.

The east entrance into the Exchange, beneath the tower, is through a short avenue, with some shops on each side of it, and receives some light, about midway of it, from an area or small open court on the upper floor. We are not at present sufficiently acquainted with the interior to be able to enter into any description of even the principal apartments on that floor. Very probably, little more than the arrangement of them, and their respective dimensions, are as yet settled. We can speak only as to a few particulars, and those merely of plan, in regard to Lloyd's, the staircase leading to which is a spacious semicircle, partly formed by the curve of the north-east corner of the structure. From this a wide corridor, or gallery, with columns and arches, serves as the approach to the principal room over the colonnade on the north side of the cortile, having windows (as at present designed) towards that court, and others on the opposite side, towards Threadneedle-street. The plan of the room itself is irregular, being wider at the east than at the west end; but this defect is in some measure overcome by introducing a range of Ionic columns on each side, so as to make the centre space a regular parallelogram; but we think it would be a decided improvement, if pilasters were placed immediately behind the columns and the spaces between them converted into separate recesses, because their being unequal as to depth would be of comparatively little importance, hardly noticeable in a general view of the apartment, whereas the obliquity of the side walls to the lines of columns is a very awkward defect—one that must sadly detract from the architectural effect apparently aimed at, and by which it is rendered more offensive, while it is also one that must be obvious at the very first glance.

It will perhaps be considered fortunate that, for want of fuller information, we can go no farther than this into any account of the interior, for our paper has extended to such a length that our readers will hardly regret that we are here compelled to take leave of them. We will not promise them, however, that we shall not return to the subject again; because whether we do so or not will depend upon circumstances and opportunity. As regards the opinions contained in them, we can say no more than they are sincere, free from either prejudice or partiality: how far they are correct it is for our readers to determine, but, in whatever light they may regard them, hardly will they deny that what we have said shows something like a diligent and careful consideration of the subject.

[It is, perhaps, necessary to remark, that the foregoing article, and that which appeared upon the same subject in our seventh number, are the work of different writers, which will account for any thing that may appear either like descrepancy or repetition. However, whilst the first paper supplies information not introduced here, the present brings forward for consideration much that has not been touched upon at all in the other article.

For ourselves, we would remark, that we think many of our readers will not agree with the writer as to the expediency of leaving a mass of building in front of the new Exchange on the west, when there are the opportunity and the means for removing what appears to us to be an incumberance. The suggestions with respect to covering the area of the Exchange are very valuable. By the instructions given to the architects they were left without any choice in the matter, and it appears to us that Mr. Tite's design for the interior court, hypœthral though it be, presents many agreeable features, and is a well conceived and well managed arrangement. The hint for filling the pediment of the portico with sculpture will, we trust, be taken,—a finer opportunity for the genius of our sculptors has perhaps never occurred; and, surely, with the co-operation of two such wealthy and influential bodies as the Corporation of London and the Mercers' Company, means would not be wanting for so desirable an object.

We may probably return to the consideration of these subjects, and to the architecture of the interior court, in a future number.]

RAIL-ROAD ACCIDENTS.

Sir,—Having observed the lamentable reports of the late accident on the Eastern Counties' railroad, which every member of society must sincerely deplore, I consider that every one who can point out practical means by which such calamities can be prevented for the future is bound in honour and conscience to do so, leaving the public intellect to be the umpire, when the case is explained to them publicly, as well as to the general Directors of the railroad companies, and who, I have no doubt, will give their general attention to the subject, in order to relieve themselves from any suspicion of not doing their duty in any respect, both to their own interests and to the public, of which however I for one acquit them: hence this is my deodand, at the same time stating that I have not the least interest in any of them, excepting that I wish them success in their undertakings.

Therefore, considering all the calamities that took place, and the attendant circumstances, such as crushing, burning, and scalding to death, the engineer and others, I will now endeavour to develop and explain, to the extent of my humble abilities, the main cause how, in my opinion, the late accident was occasioned, and which, I consider, will clear the engineer from any wanton destruction, independently of his own life, and which surely is loss enough for his family to suffer, without being taunted.

I shall therefore take the first report which appears consistent with the nature of the case, namely, that one of the men belonging to the train, but without any authority, on his being frightened, and seeing the great velocity of the train, forced down the break, in order to stop the wheels of the propelling carriage, and that without the knowledge of the engineer, who, I presume, ought to have the agency of the whole under his control, in the same manner as a common stage-coachman has over his vehicle. If he happens to have one of his reins broken, it is not consistent for a passenger to take

the remaining reins from his hands to stop the horses; if so, as with this question, daily accidents must occur.

The very circumstance of a powerful break or a lateral press being at once put down on the propelling wheel to stop the engine carriage or the train, when at full speed, and that without the knowledge of the superintending engineer, or his preparation for so doing, by shutting off the steam from the piston of the engine, and which is the first thing he ought to do before he attempts to put down the break, deserves attention, for otherwise the action would tend to jump the carriage out of its track by rocking it to and fro, as the impetus of the whole train, when at a great speed and heavily laden, may perhaps be ten times the power of the engine. Thus the momentum of the two powers when in full force is terrific in its nature, if the breaks are put down instanter, and which none but a maniac would do.

I therefore repeat that unless the engineer is apprized of the intention to stop the train before he can shut off the steam, similar accidents are liable to occur, and for this reason, the wheels thus connected with the break by its lateral pressure cause such an instantaneous pressure of the wheels on the rails on which they run, that the immense friction so caused by their adhesion together, as it were, is likely to tear up the rails by their roots, and which friction together would cause a natural or uniform jump of the carriage off the said rails, whilst the whole power of the steam is on the piston, at the time when the whole train is at its greatest velocity or active operation, hence the momentum of the whole is thus enlisted as it were for the destruction of the whole column. The above precept I will challenge the host of civil or uncivil engineers to refute by hypothesis.

It is generally known amongst the enlightened philosophers of the day, that windmills have breaks to stop them, either in, or in anticipation of, a gale or storm, in order to unfurl their sails to prevent too great an influx of wind acting upon them, to the utter destruction of sails and machinery attached thereto, in which case the wily miller puts down his break in a cautious manner, and then gradually eases it down, so that neither the sails nor the machinery are out of order. But if a storm or high wind should spring up instantaneously, and he slaps down the break instanter, the consequence is that the sails are all twisted off, provided they are fully clothed. Hence the machinery is also racked to pieces, and all the geared wheels stripped of their cogs.

The above is an exact similitude with a locomotive train of carriages, and, when in its full career of velocity, as the windmill is in a storm, if it be stopped by the break instanter, the whole must be thrown into desperate convulsions.

I have the honour to be, Sir,

Your most obedient servant,

James Surrey.

Battersea, September, 1840.

[We are of opinion that, from the way in which, and the parties by whom, Railway speculations have been got up, there are more general causes of accident, in some of them, than that noticed by our correspondent. We shall make some inquiries.—Con.]

FULHAM COLLEGE.—CATCHING BY STEAM!!!—COLLEGIAN PROCESS.

The surprising attraction of the Eccaleobion, in Pall Mall, has suggested the formation of a similar establishment, on a scale of extraordinary magnitude, at Fulham.

The object of this institution is to render the wonderful power of steam applicable to the production of young engineers, "whereby," in the words of the prospectus, "countless thousands of the engineering profession, from a STAFFMAN to a M. I. C. E., from a STOKER to a MAUDSLEY, may be produced by machinery."

The astonishing results which must inevitably flow from so grand and magnificent a scheme need no remark: the wondrous doings of Mr. Green in "the liquid regions above the earth," the exploits of Colonel Pasley, "in the waters under the earth," sink into utter insignificance, and, in comparison with the forming civil engineers by so ingenious and elegant a process, are as naught.

Our space is too limited, our pen far too feeble, to do justice to the master-mind which could conceive, or to the bold and *disinterested* spirits which have carried out, this singularly original idea; but we may venture, all unworthy as we feel ourselves, to point out some few of the leading features of the new system.

Its distinguishing characteristic, then, is the extreme rapidity with which the effect is produced. Contrary to our narrow views, the COLLEGIAN PROCESS wastes no time in previous study, requires no peculiar talent for the profession, but at once, and infallibly, stamps on the shapeless and unformed mind the perfect knowledge of the experienced engineer. Our Telfords and our Rennies were wont to hold that talent, study, and the practical experience of years, were necessary. Alas! for such prosers! The college sages laugh them to scorn; expose their antiquated prejudices, repudiate their absurd notions, and with the conscious dignity of superior merit point to Fulham. "Come ye of little faith," they cry, "pay your admission fees, down with your dross, and your sons, albeit the veriest boobies that e'er essayed the *pons asinorum*, shall become eminent engineers." "Clothe them in uniform, thrust them in at the front gate, and, as Medea restored to life and pristine youth the worn-out aged man, these tyros shall, under the potent Medean art of the PROFESSORS, issue from the back gate in all the radiance of literature, science, and knowledge." Who shall doubt these eminent men, and cry, "A puddle in a storm?" Are there not PLAY-GROUNDS of vast extent to survey? Are there not TOY BRICKS to build bridges with, and JACK CHAINS for suspension bridges? Is there not a GUTTER (I mean a CANAL) to practise on? and who shall doubt that thus engineers can be made? *proh pudor*. Hasten to secure these advantages, ye parents and guardians, for your sons and wards, purchase tickets of admission quickly, lest all be sold, and you be left to mourn with unavailing regrets that had you not tarried your hopeful charges had by this been manufactured into Cubitts or Brunels.

Prospectuses (one of which shall appear in our next number), may be had at the CATCHING BY STEAM COLLEGE, FULHAM, and every information may be obtained at 999, Villains' Street, Strand.

Philo. M. I. C. E.

TRAFALGAR SQUARE AND THE NELSON COLUMN.

After what we have already said, it will be taken for granted that we ourselves consider the question deliberated upon by the committee of the House of Commons almost a superfluous one, since the difficulty would be to show that the Corinthian column put forth by Mr. Railton, as a design for the Nelson Monument, ought to be carried into execution at all. We do not want a third curiosity of the kind in the metropolis, because, like all other mere wonders, they lose their importance greatly by being rendered too common; and of such "tall bullies" we have enow at present; in fact, almost a regiment of them, as any one may convince himself by walking on to Waterloo Bridge, where he will see them lifting up their heads by scores—not, indeed, exactly in the form of columns—no such absurdities, but lofty towers and manufactory chimneys, of column-like proportions, and of *monumental* dimensions. It is true, people see nothing to admire in *them*, because they have not been told that they ought to do so, and that they would show their taste by abandoning themselves to ecstasies of wonderment at them. Nevertheless, if we may credit the new professor of architecture at King's College, whose opinion ought to pass for something, we may throw away our admiration on worse structures, even looking at them merely as objects of taste, for in his treatise on architecture he not only ventures to compare together the "Monument," and the Shot Tower near Waterloo Bridge, but actually decides in favour of the latter.

However, let us *return to our muttons*, as the French say,—to the *sheepish* maypole affair, on the top of which Nelson is threatened to be stuck up like a sweep peeping out of a chimney pot, where he may sniff all the soot and smoke of the whole metropolis. There is, indeed, one circumstance in this unlucky Nelson monument business that we most heartily approve, namely, that some inquiry has been made into it, and that the opinions thereby elicited have been published. And devoutly is it to be wished that the same publicity were given to all the transactions and discussions—if there ever be any discussions on such occasions—atten-

ding architectural competitions. Had, for instance, the very excellent reasons which induced the Nelson committee to adopt Mr. Railton's nicely drawn column, been given to the world, both the world and ourselves might have been convinced, and brought over to their way of thinking; whereas, now being left in the dark as to their reasons, we are left at liberty to *rail* at the choice.

Of opinions and reasons, the "report" furnishes us with no small number, and now that they see them all together upon paper—fairly recorded in black and white—those who delivered, will probably wish that they had given a little more consideration to them, for some of them are as opposite to each other as the north and south poles. Yet, before we proceed farther, we may as well remark—now that it occurs to us, that there is one question which has not been taken into consideration at all, and that is, what effect will Mr. Barry's terraces to the area have on the surrounding buildings generally. As far as the Gallery is concerned, there can be no doubt that the façade will be greatly benefitted by the terrace in front of it, and upon which it will seem to have been reared, when viewed from any distance. Yet we have some misgivings as to whether such will be at all the case in regard to the buildings forming the east and west sides of the square, more especially as the design for the terraces, &c., has been described to us as unusually ornate and stately, with courses of rusticated masonry, combining richness with solidity of expression. Is it likely, then, that the miserable flimsy-looking range of houses on the east side will look at all the better, when seen in combination with such a foreground to it? We apprehend not; neither do we imagine will the opposite Union club-house and College of Physicians be at all more benefitted by Mr. Barry's plan. The effect in regard to those buildings, will, we conceive, be attended with more of antipathical than of even picturesque contrast; nor do we exactly understand how—as Mr. Donaldson seems to think, the awkwardness of the east side of the square can be in any degree masked by the lower area of the square being made perfectly regular in shape, because the terrace or boundary-wall on that side must rather have the effect of showing how very much out of that parallel the line of buildings is. That it should have been suffered to have been so carried, instead of being made parallel to the west side, which was the one first built, is one of those unaccountable oversights that generally happen where there is no responsible *overseer*; one of those provoking mishaps which are all the more provoking, because, when the mischief is done, nobody is to blame. In the present case, our consolation must be that the mischief is not irreparable, for that range of houses is not a piece of architecture of such a noli-me-tangere kind that it would be an absolute profanation to remodel it in such manner as to bring the square into some degree of regularity.

We will now proceed to consider the opinions of those gentlemen who were called upon for them, by the committee. In regard to the first one of the questions proposed to them, namely, what effect the intended column would have upon the National Gallery, they were almost unanimous, all agreeing that it would, more or less, detract from the importance of that façade, and render it a secondary architectural object.

Question II. What effect the column would have as an ornamental object in combination with the surrounding buildings? drew forth some rather conflicting answers to it; for while, according to Mr. Donaldson, the effect would be "an advantageous one," Mr. Gwilt gave it as his opinion that "the proposed column will not group well with any of the surrounding buildings, and least of all, if there be any difference, with the National Gallery." Again, while Mr. Sidney Smirke thinks "a fine architectural scene would be produced," Sir R. Westmacott says, the general effect will in itself be "bad." Therefore, we have Donaldson and Smirke – to whom may be added Blore and Hardwick, in favour of the column, as far as this particular question is concerned; and Gwilt and Sir R. Westmacott, and also Decimus Burton, against it, or four ayes to three noes.

But there is still another negative, and that a very emphatic one, to be reckoned, namely, the opionion of Sir F. Chantrey, who, among other observations, remarked: "the Trajan, the Antonine, and the Napoleon columns, are the only monumental objects of this class that I have ever looked upon with entire satisfaction; I there read the history of the man on the shaft of the column, and the mind is thus reconciled to see the statue so elevated. I may be told, we have not money enough for a work of this character, that naval exploits furnish bad materials for sculpture, or that the arts of this country are in too low a condition to accomplish so noble a work; then, I say, *abandon the impossibility at once, and try something more in keeping with our means and our genius.*" Bravo! Sir Francis! So too say we; abandon the paltry Brobdingnagian bauble of a mere "amputated column," stuck up to make those of the surrounding buildings appear quite Lilliputian. Let us have something less mawkishly stale, and less bunglingly servile, than a column à la Trajan, without its sculptures.

Question III. What effect will the column have on the National Gallery as you approach it from Whitehall? might, we think, have been spared, since it is tolerably obvious that so viewed, the façade of the gallery is merely an indistinct object in the distance, indicated chiefly by the outline of the dome against the sky. Therefore, as far as the view from that particular point is concerned, we see little objection to the column—if column there must be—on the score of its intercepting in some degree a view of the buildings beyond it, because it will certainly afford a sufficiently prominent object in itself at the termination of the vista from Whitehall. In fact, now that the site has been changed, so that at all events the column will not occupy the centre of the square, we think it would be advisable to remove it still farther off, and adopt the suggestion thrown out by a correspondent of the Athenæum, who has recommended that it should be erected on the spot now occupied by the statue of Charles I., and the latter placed within the square. The column would serve very well to fill up the triangular embouchure towards Whitehall, where the crossing for foot passengers requires to be greatly more contracted; and by accommodating the form of the pedestal in some degree to the lines of the houses, a little more novelty of character might be obtained. For this purpose, it should be a triangle with its points cut off, at which truncated angles might be placed three "victories," or statues, symbolizing the actions of Aboukir, Copenhagen, and Trafalgar, and the pillar itself might be an hexagonal prism, on the sides of which might be pannels decorated with reliefs and naval emblems. The annexed sketch of such plan will serve to explain our idea, and to show the position of the statues, that allusive of Trafalgar, T, being directly facing Parliament Street; while of the six faces of the pillar, one would be seen nearly directly in front, in turning down from Cockspur Street, and another from the corner by Northumberland House, with the statue at that angle of the pedestal.—But we are now dreaming, and our poor *muttons* are waiting for us. In regard then, to question third, the answers were unanimous, it being agreed, *nem con*, that it would be impossible to see through the column, even were it only a column without a basement, consequently, it would more or less intercept the view of the National Gallery, if, in order to look at that building and see it to full advantage, people chose to go and plant themselves where the column would be in a direct line between themselves and the gallery. If, however, there was no clashing of opinions in regard to that question, such was most assuredly not the case with respect to

Question IV. How far do you consider that position a favourable position for the column itself? For if Messrs. Blore, D. Burton, Sir

F. Chantrey, Hardwick, S. Smirke, Sir R. Westmacott, and Deering, all expressed themselves decidedly in favour of the position of the column, taken without reference to any thing else, Mr. Gwilt's opinion was in point blank opposition to theirs, his words being, "I do not think the position favourable for any column or monument;" adducing as his reasons that such an object requires to be set off by a background, decidedly contrasting with it in colour and material, so as to exhibit its outlines perfectly. The other dissentient was Mr. Cockerell who opines that the area formed by the buildings around Trafalgar Square is *too large* for the proposed column, at least for a single one, and, he therefore recommends a pair! a Gog and Magog, to stand as sentinels in front of the National Gallery, and keep watch over their little Corinthian relatives in its portico! One comfort is, that there is no danger whatever of this notable scheme being adopted.* Yet, though we so far differ from Mr. Cockerell, we rather incline to agree with him that the area as defined by the surrounding buildings is too spacious; which is one reason wherefore we would have such a pillar placed, if in that neighbourhood at all, where Charles' equestrian statue now stands. Mr. Barry, on the contrary, had previously given it as his opinion before the committee that the area was "too small and confined for a column of the height and magnitude proposed," inasmuch as the effect of the latter would be to reduce the apparent size of the square, and render the surrounding buildings "insignificant." Such would undoubtedly be the case; therefore every pillar of the kind ought to be situated within an architectural area expressly adapted to it, and serving as a court or enclosure surrounding the pedestal, and proportioned to this latter, both as to superficial extent, and the height of the buildings forming its sides. It has very long ago been discovered, if not by philosophy, by common sense, that when two men get up upon the same horse, one of them must ride behind the other; in like manner a colossal column must seem either entirely to occupy the area in which it is placed and to render the buildings around it quite subordinate accessories,—consequently, these latter should make very little pretensions as distinct architectural objects; or else, if importance is to be given to the general area and the buildings enclosing it, the column itself will become a mere adjunct or expletive, an ornamental central object, nothing more. Instead of striking as a colossal mass, it will be only a *big* column; and bigness and grandeur so far from being invariably the same qualities, frequently happen to have nothing in common.

These considerations are no doubt exceedingly perplexing and embarassing, for they seem to leave us only a choice of disadvantages. Why then, we ask, should the idea of a column be absolutely adhered to, when we may so easily secure all that recommends that form generally as affording a lofty architectural object,—without what renders it objectionable, not to say absurd,—by converting it into a monumental TOWER? That being done, the comparison which must else prove so injurious to the porticos of the Gallery and St. Martin's Church could not take place. The greater loftiness of such tower would no more interfere with those features and their columns than that of the spire of the church itself now does. To be sure to design such tower requires somewhat greater exercise of imagination and taste, and a little more *nous*, than merely to draw a Corinthian column. It is not a task to be understood by every one, or by an every-day artist. True, neither was Nelson himself an every-day admiral, one of the people whose names serve to fill up the Navy list. Let us beware lest in erecting an honorary monument to him, we erect a monument of disgrace to ourselves, one that will manifest the deplorable imbecility of art in this country.

Why not even now have a Third Competition, limiting the programme to some ornamental structure approaching to column-like proportions, and expressly adapted to the area as laid out by Mr. Barry? Why not? because of the obstinate pig-headed sulkiness which is invulnerable to all argument; because of the paltry sneaking false enonomy that will induce the Nelson committee rather to persist valiantly in carrying out a blunder, than let it be said that they inadvertently buried some of their cash below ground in Trafalgar Square; in short, because notwithstanding all the blustering and vapouring beforehand, about art, talent, and all the rest of it, the body of the Nelson committee neither understood nor cared three straws about such matters.—*Diximus!*

* There are, indeed, two rostrated columns, serving as phari, on the quay in front of the Exchange at St. Petersburg, but they may be considered as forming part of composition of the design for that structure, which is seen between quite insulated, and to which they rather give additional importance than not.

REVIEWS.

IMPROVEMENT OF THE PORT OF LONDON.—BY MINIMUS.

THE river Thames is at once the glory and the shame of the British metropolis. It is the glory in so far as it is the production of nature; and the shame in so far as mankind have interfered with it. Its magnitude and convenience are such that no neglect or bungling treatment can absolutely ruin it for the purposes of navigation; but the crowding of vessels, the turmoil kept up by innumerable steam craft, and the danger to small boats upon its constantly disturbed surface, are increasing every day, and render even its valuable waters unpleasant to the view of a rational beholder. The banks, however, especially as they appear at low water, are the great eye sore, irregular as they are in their outlines, and foul as they are, with the accumulation of ooze, sludge, and all the rejectamenta of a great city.

The vast number of proprietors to whom the several parts of these banks belong, the various purposes to which the different owners turn their portions, and the countless shades of bad taste which they display in their erections, all tend to make the Thames, within the limits of the London trade, truly "the river of Babylon." The corporation of the city are conservators of the water of the river, for a very long distance, both above and below the centre of London; but they are not conservators of the banks; and we believe that the water would flow as usefully to the sea, without their conservation, and the formality and feasting of their visits, as it does with them. Over the banks they have, as we have said, no control or power, which can in any way tend to the improvement of these; and, therefore, even were we to grant that those civic wardens of the water have talent and taste enough for rendering the Thames that securely and ornamental thing which it might be rendered, neither they nor any other party within the country have the power of bringing their wisdom and their wits to bear upon this highly interesting but shamefully neglected subject. The executive government has no power but what the law gives it; and before parliament could be put in motion to effect any improvement, the Right Reverend, Right Honourable, and Honourable, (some of them not very right) members of the two Houses, would have to waste the breath of a whole parliament before they could persuade the people of the kingdom generally to pay for works which ought to be done by the population of the metropolis only, and the neglect of which is one of the greatest disgraces which attaches to that population. The Thames has been from the beginning the grand source of London's wealth; and it is perfectly shameful that, in an age of ostentatious and expensive, if not always tasteful, improvement, the Thames should be utterly neglected. To us it seems that this most valuable river is the type of that which is called the public good, which is loudly in the mouth of every man who longs to lay hold of his fellows and carry them gently by the ears like rabbits, but which every man invades, puts clean aside, or mangles for the most insignificant of private purposes.

Many plans have from time to time been suggested, some for the mere dandification of the metropolitan banks of the Thames and others for the real improvement of them; and the removal of the obstruction caused by Old London Bridge has shown what is wanted to effect the latter purpose, namely, greater rapidity in the current of the water. The only way of obtaining this is by narrowing the channel nearly or altogether to low water mark, along the whole line; but experience of the insatiability of individuals for compensation in the case of public works which obviously tend to improve their own property has been so

universal that a great portion of the comforts of the nation would have to be sold, in order to buy an improvement of the Thames, for the local beauty and benefit of London.

A fresh project for this purpose, originating with "Minimus," and published by Smith, Elder, and Co., of Cornhill, now lies before us in a one shilling brochure, the profits of which are to be generously appropriated to "public purposes," the pamphlet itself being, of course, meant to serve more individual and private ends, the clearing of the understandings of men upon the subject of the Thames and its feculent deposits. The project is to excavate a collier dock at Tower Hill, and to construct two detached quays, one along the low water line of each side of the river from Vauxhall Bridge to somewhere about Greenwich, it being suggested, and fortified by much weight of calculation, that the rubbish excavated from the dock at Tower Hill, would supply materials for the detached quay on the left bank of the river. In supplement to this the scheme professes that there should be public baths at the Tower, at the Temple Gardens, and at other places, together with cesspools, to receive all the sediment of the common sewers, and thus send their contents sweet and limped into the river. All this, in the opinion of Minimus, would be done at small expense, would affect no man's private property or interest, would greatly reduce the prices of commodities, and give to the country a permanent boon of from 100,000,000*l.* to 200,000,000*l.* All this is made out in the brochure, much to the satisfaction of the author no doubt; but the absurd calculations of De Moivre and Price, about paying borrowed money by means of a sinking fund consisting of a small fraction of the same, have long ago taught us that the figures of arithmetic may be as great story tellers as the figures of speech.

Supposing, however, that the two quays, and so forth, were erected, and all the banks to landward of them were to remain in *statu quo*, what would be the real effect upon the river? In plain English, its waters would be divided, and its abominations multiplied; for those landward spaces having no current to scour them, would right soon be silted up with matters of the most offensive description. The water, when it remained in them, would, of course, be stagnant, and being stagnant it would become not only poisonous, like the water in the London docks, which, be it remembered, does not owe its deadly qualities so much to the solution of the copper sheathing of vessels as to phosphoretted hydrogen and other poisonous gases which are retained in its mass; for it would be intolerably offensive from the exposure of the mud; and thus, even were the scheme practicable, which it is not, its natural and necessary tendency would be to margin both sides of the river with pestilence.

We need not enter farther into the matter of the brochure; but, we must say one word of the manner: Minimus, having exhausted the whole of his own cogitations, in 53 pages and 1 line, falls to sermonizing in the remaining 15 pages minus 1 line. If the concluding homily is not good, it is at all events fervent; but, it is woefully out of place, and shows very bad taste, as bad in fact as the judgment respecting the improvement of rivers which is displayed in the interior part of the pamphlet. Ever since we have read it, and we have read it, though certes "with difficulty and labour hard," we have been unable to get out of our minds a saying we once heard used by the same gentleman who waged war upon the tigers in Sagur, in the offing of the Ganges, and was ultimately beaten by Tippoo, with more numerical loss than that woodland warrior. So in order to clear ourselves of this memorial, and be fresh for the campaign of our next number, we shall transfer the saying to our readers. Some 15 years ago, the exhibition of a pretended mermaid, in Regent's Street, was attracting he wide-mouthed wonder of the metropolis; and the gentleman alluded to and ourselves went among others to see the prodigy. After close inspection he exclaimed, "It is nothing after all but the head of a monkey sewed to the tail of a salmon;" and, in like manner, this pamphlet is nothing but the head of a dream sewed to the tail of a sermon.

"SPECIFICATIONS FOR PRACTICAL ARCHITECTURE, WITH AN ESSAY ON THE DECLINE OF EXCELLENCE OF MODERN ENGLISH BUILDINGS, AND REMEDIES FOR THOSE DEFECTS." BY ALFRED BARTHOLOMEW, ARCHITECT. 1840.

In the specifications themselves, consisting of nearly four thousand paragraphs, will be found all particulars that can possibly be required respecting bricklayers', carpenters', smiths', plumbers', glaziers', and painters' work for dwelling-houses, hotels, Gothic lodges, national schools, workhouses, workshops, breweries, fire-proof savings' banks, church, chapels, mansion-house, &c., and directions for giving notices for shorings, &c., forms of contracts and general conditions which may be added. This portion of the work will be found of incalculable advantage to the practical man, being a constant guide for him from the first commencement to the completion of his work. "There are *two classes* of persons," the author says, "for whom this work is not intended: — the first consists of those who, by a long course of research and practical devotion to the subject, have formed better conclusions of their own, and who, by their own industry and knowledge, have acquired a more methodical and pains-taking mode of doing their work: the second class consists of those who by nature cannot, or will not, seek to develop the niceties of their art; and, who from incompetence or inattention, can neither appreciate method and exactness in others, nor follow either of themselves. From the first class, in humility, the author would learn every thing by which he could improve his work; from the faults of the latter class, he would wish it, if possible, altogether purged. There is yet *another class*, for which this work is not intended, viz., those who fear to lay before their employers, at one view, a correct statement of all the particulars of a contemplated work, lest those employers, frightened at the extent of them, and at the amount of the estimate of the probable outlay, should either altogether lay aside the design of building, or else spoil every part of the work by improper erasures; and, if the professional man should either decline to carry into execution so bad a project, or show unbendingness in any part of the matter, will find some other person, destitute, perhaps, of constructive knowledge, and less honest, but more complying."

The author proceeds in his work very warily, starting no new proposition until the one in hand is completely laid and fairly picked to pieces. He lets fly his ammunition in all directions, without any qualms of conscience, against all innovators from the first cultivation of the science down to the present time. Here we have a lash at the general use of external stucco, first patronized by a *would be* Augustus; then on the perverse spirit in using the most perishable materials for architectural purposes; now a Philippic against the carelessness of using combustible materials in public buildings, and also the use, or, rather, the abuse, of glue, or solder, and other cements, and, then, on the heresy of turning arch from classical column to classical column, copied from the corrupt examples of mid-æval and modern Italy. We have a good chapter on the vice of not finishing buildings as they were originally designed, in which Wren and Chambers deservedly meet their due, and the Custom-house and King's College *improvements* are characterized in their true colours. "The alteration of an original design, when once begun, is the greatest mark of self-sufficiency, on the part of the architect; it always causes immense injury; and no good whatever, to any building, has ever resulted from it. This pernicious self-importance is the true reason why we have such a number of odds and ends of buildings, *but so few of them complete.*" Meanwhile, our author tells of the disputes that arise from badly drawn specifications, a great source of expense as well as trouble and vexation to the architect, and he is no great friend to the modern plan of calling for contracts and estimates, bad execution, in an "enormous number of cases," being almost inevitably the result of the former. "It is not," he says, "that a contract ought to insure the bad execution of the work; but the party with whom the contract is made does, in many instances, so insure it. Formerly, many and the noblest and most intricate works were executed by con-

tract: the astonishing stone roofs of King's College Chapel at Cambridge, and St. George's Chapel at Windsor, were so performed; they were "*workmanly wrought made and sette up after the best handlynge and forme of good workmanship, according to a plat thereof made and signed*," the contractors agreeing that they "*shall provide and fynde at their costs and charges as moche good sufficient hable ston*," "*with lyme sand, scaffolding, cinctores, moles, ordinaunces, &c.*," as should be necessary. But, then, a contractor who would *deal faithfully* was found, and was employed *because he would so deal*, and *deal so he did*, and his work is become a proverb in the land, &c. A contractor is not *now* employed because he is known to be a skilful and a faithful man; a public advertisement is put forth, and except in such undertakings are only within the ability of a very few large capitalists, this acts as a warning to most trust-worthy tradesmen to keep aloof, while it acts as a call to the needy, the incompetent and the dishonest."

In Chapter XXIII. we have a complete list with some excellent remarks of the literary and graphic works which an architect may possess and consult with advantage to himself, but we suspect, it being a formidable affair, such a library would be far too voluminous for the purpose. Some excellent instructions respecting foundations, the centre of gravity, the mechanical trussing of bridges, of abutments, the excellence of Gothic arches, and the unscientific positions of rafters, roofs, &c., with what nature teaches us with regard to the coverings of roofs; and, how "unwise, unnatural, fragile, expensive, and dangerous are the cementitious compositions which are adapted for the coverings of buildings."

"Nature cover the bodies and limbs of birds and beasts with feathers and hair, laid in small portions one under another, beneath which the creatures may freely move, carrying their roofs with them; and, she even provides many species of them with oil, to throw off wet the more effectually. Man, who is, in himself, so little provided against the inclemencies of weather, soon discovered nature's mode of roofing, and adopted it. Thatch, shingles, weather-boarding, tiles, slates, lead, copper, have all along been used in this mode, with various degrees of excellence: under all these, the building may settle greatly, and yet no water penetrate the covering.

The pretence of improved science, or of economy, now leads the unwary to adopt various kinds of cementitious coverings; these of a nature so rigid as to flaw with every jar and settlement of the fabric, and, with every accident, intercept the rain water in its flow; the rays of the sun, the contractions of frost, keep all these fragile unaccommodating substances constantly in a broken state; that water which by other coverings is thrown off, is with avidity drunken by these; hence, all within the fabric is ruined: houses thus roofed are as much exposed to the weather as birds and beast would be, if their feathers and hair were plucked from their bodies, and were laid again upon them without order. In such roofs, the laws of nature are violated; they cannot, therefore, be either scientific or economical. Frequent renewal cannot lead to economy; constant fracture cannot be security; the penetration of wet, and the destruction of the supports of a roof cannot be freedom from danger. Even the construction of a roof flat, to be covered with lead, requires more skill and caution than are usually possessed by the makers of cement roofs; what success, then, can attend their inferior skill, guided by improper feelings, and working with unmanageable commodities? The makers of inflammable roofs should everywhere be prosecuted as public incendiaries. By the forty-seventh section of the London Building Act, roofs are to be directed to be covered with glass, copper, lead, tin, slate, tile, or artificial stone: if, then, in the Metropolis that description of civil liberty, which requires that each man's property should be protected from consumption by his neighbours, if every inmate of a building, should be preserved from jeopardy, what plea can be set up for covering roofs with bituminous tesseras, or with Jew's pitch?"

The author proposes a plan for the foundation of a great national college, for the study and regulation of architecture throughout the British dominions, for the examination of students and professors of architecture and artificers in building, for granting honorary degrees to proficients of various stages of maturity, and for the conservation of public buildings; but, upon the practicability or not of the scheme, we cannot, at present, enter into a discussion. To the end of the work is added a complete abstract of the London Building Act, arranged alphabetically with references to the sections; indeed, this method of arrangement, with the addition of a copious index, is by no means the least commendable portion of the book, as instant reference can be made to any portion or subject. Some valuable notes are added, among which we are pleased to see the following observations on Portland stone:—

"It is to be regretted that, in the present age, research should be terminated by a comparatively profitless conclusion. About three years ago, the author projected a tour to our principal quarries, and performed a small portion of it; the necessity for this has been, in a considerable degree, superseded by the government undertaking of the year 1838, by Messrs. Barry, De la Beche, W. Smith, and C. H. Smith; but the deductions of so valuable a body of information are rather of a fearful nature. From the first coming into repute of the Portland quarries, Jones, Wren, Hawksmoor, Flitcroft, Gibbs, the Dances, Taylor, Chambers, Soane, Smirke, and other sterling English architects, have in successsion used its beautiful stone in every good building, and some of them never chose any other kind. In most cases, the masonry of the oldest buildings by these architects, who were always curious and exact in the construction of it, is more perfect than that of any recent modern edifice of inferior stone. One would have supposed that the example and success of these chiefest men in their profession would have caused no slight pausing before entrance upon the recommendation of an inferior material for the Houses of Parliament. The real cost, however, of Bolsover-moor stone, will, it is hoped, if nothing else can, do that which good taste could not, and, save a sumptuous and magnificent building from the infliction upon it of a fullers' earth aspect: besides, rustiness of colour, this material is fit only for masonry of mean quality. The thickness of its beds, which are only from eight to twenty-four inches, renders it totally unfit for window mullions: placing the stone on end, or the mixing with it for such a purpose the product of other quarries, is alike to be deprecated by good practice and good taste. Let those who wish to see stone perfect in colour and condition, examine the Portland stone columns of the porticos of Chelsea Hospital, in those respects, perhaps, the finest in the world. Those who have been reduced by bad times and bad public judgment, to a sort of necessity to sacrifice goodness of material, for elaborate architecture, quickly decaying, and who have thus succeded, under the colour of economy and superior talent, in obtaining high station in their profession, may, then, cease to tamper with good architecture, resolutely refuse to build with other than the best masonry: if they use the choicest Portland stone, their work will remain, and will rank with those of their justly celebrated predecessors. The Reform Club-House, in Pall Mall, which will probably outlive its political destination, is both an instance of the wise substitution of Portland stone for inferior material, and of the sucesss of employing symmetry, boldness, and simplicity of architectural character."

One question, indeed, which our author raises, on the possibility of procuring stone-quarries at London, and near other great cities, by digging down to the chalk stratum, which passes under London, thereby changing our great city from one of the meanest, and composed of most fragile materials, to the grandest and most substantial on the face of the earth, we have great doubts on account of the enormous expense of the undertaking placing the material beyond general use. There are some few points in the work in which we cannot possibly agree, in spite of all Mr. Bartholomew's cogent reasoning, and we have so little regard for our personal safety that, on these, we should be rash enough to take up our cudgel and bear the brunt of even his invective sooner than give way. However, taking the work altogether, it contains far too many beauties, is written not only in an instructive but a very amusing style, and such a spirit of independence, and carelessness of censure where it is due, runs through the whole diction that will not fail of placing it in a high rank among our architectural works. In a somewhat lengthy preface, though by no means, the least deserving part of the book, the author states that he has been occupied for a period of twenty years in research and study for his work; we are sure that in one sense, at least, his time will not have been unprofitably employed, and we hope that, in the more lucrative meaning of the term, he will not be disappointed. The book is embellished with no less than one hundred and sixty explanatory wood cuts, and its appearance displays no want of care either in the printing or other matters.

INSTITUTION OF CIVIL ENGINEERS.

Continued from page 190.

March 24, 1840.—" On the Manufacture of Flint Glass." By Apsley Pellatt, Assoc. Inst. C. E.

Flint glass, called by the French "cristal," from its resemblance to real crystal, is composed of silex (whence the English name), to which is added carbonate of potash and litharge, or red lead; to which latter material is owing, not only its great specific gravity, but its superior lustre, its ductility, and power of refraction. It is necessary for optical purposes that flint glass should be perfectly free from striæ, otherwise the rays of light passing through it diverge and become distorted, and this defect is caused by the want of homogeneity in the melted mass, occasioned by the difficulty of perfectly fusing substances of such different density as the materials employed. The materials, being properly prepared, are thrown at intervals into a crucible of Stourbridge clay, which will hold about 1600 lbs. weight of glass when fused. The mouth of the crucible is then covered with a double stopper, but not luted, to permit the escape of the moisture remaining in the materials, as well as the carbonic acid gas and excess of oxygen. It requires from 50 to 60 hours application of a rapid, intense, and equal heat to effect the perfect fusion of the materials, and to drive off the gas; during which time the unfused particles and excess of salts are skimmed off as they rise to the surface. The progress of fusion cannot be watched, nor can any mechanical means for blending the material during fusion be resorted to, lest the intensity of heat requisite for the production of a perfectly homogeneous glass should be diminished, the quality of the product being influenced by any inattention on the part of the fireman, as well as by the state of the atmosphere or of the wind. It has been ascertained, that there is a certain point or crisis of fusion at which the melted metal must be kept to insure a glass fit for optical purposes, and even when that point be attained, and the crucible shall furnish proper glass during several hours, should there be such diminution of heat as to require the furnace to be closed, the remainder of the metal in the crucible becomes curdy and full of striæ, and thus unfit for use. It is the same with the glass made for the flat bore tubes for thermometers, which are never annealed, because the smoke of the annealing furnace would render the interior of the bore unfit for the reception of the mercury. These tubes will only bear the heat of the blow-pipe when they are made from a metal which has been produced under all the favourable circumstances before described. It is, therefore, to be inferred, that the most homogeneous and perfect flint glass can only be produced by exposure to an intense and equable degree of heat, and that any excess or diminution of that heat is injurious to its quality.

The English method of manufacturing the flint *plate* for optical purposes is thus described. About 7 lbs. weight of the metal is taken in a ladle of a conical shape from the pot at the proper point of fusion, and then blown into a hollow cylinder, cut open, and flattened into a sheet of glass, of about 14 inches by 20, and varying in thickness from $\frac{3}{8}$ths to $\frac{1}{4}$th of an inch. This plate is afterwards annealed, and in this state goes into the hands of the optician, who cuts and grinds it into the requisite form. When a glass furnace is about to be put out, whole pots of metal are sometimes suffered to remain in it, and cool gradually. The crucibles being destroyed, pieces of glass may be cloven from the mass of metal, softened by heat, and made to assume the requisite form, and then ground. It is believed that the excellent glasses made by Frauenhoffer, and other manufacturers on the continent, are produced by some such means. On attempting to cut glass ware, it is easily perceived if it be sufficiently annealed; if not, the ware is put into tepid water, which is heated, and kept at the boiling point during several hours; it is then suffered to become gradually cold. This method is more efficacious than re-annealing by the ordinary means. A piece of unannealed barometer tube of 40 inches in length being heated and quickly cooled, contracted only $\frac{1}{16}$th of an inch, whereas a similar piece, annealed by the usual means, contracted nearly $\frac{1}{8}$th of an inch. Unannealed flint glass, being heated and suddenly cooled in water, exhibits the appearance of a mass of crystals; it is thence inferred that the process of annealing renders the glass more compact and solid; it thus becomes incapable of polarization.

Flint glass being remarkably elastic, has caused it to be used for chronometers. To prove its elasticity, a hollow ball of unannealed glass of 3 inches diameter, weighing about 16 ounces, was dropped, *when cold*, from a height of 7 feet upon a stone floor; it rebounded uninjured about $3\frac{1}{2}$ feet, but broke on falling to the ground after the rebound. Similar balls, both at a *bright* and a *low red heat*, were dropped from the same height, and both broke immediately without any rebound; thus demonstrating that its elasticity only exists while cold. Glass being sometimes deteriorated in the process of reheating, not only in colour, but in its faculty of welding, by the sulphur existing in the coal or coke used in the furnace, this is prevented by occasionally throwing about a quart of cold water on the fire; the explosive vapour thus raised carries off the sulphureous gas.

The process of annealing has the remarkable property of carrying off from the glass the reddish tint imparted to it by manganese; and in large masses, not only the reddish tint disappears, but the glass sometimes becomes green or blue, probably by the action of the sulphureous acid gas from the coke. The reddish tint will however return, and the greenish one disappear, should the annealed glass be afterwards heated or remelted. Should the pot crack during fusion, and the flame or smoke come in contact with the melted metal, a green tint and abundance of dense striæ will be the consequence. Such an accident can only be repaired, if the crack be accessible, by throwing cold water on the exuding metal, which thus becomes gradually cooled, and itself forms a lute, so as to enable the process of melting to be continued. Long experience has shown that the best fuel for melting glass in the furnaces is oven-burnt coke mixed with a small quantity of screened coal.

Mr. Pellatt illustrated the preceding paper by specimens of glass, exhibiting peculiar effects of crystallization; among them were cylindrical solid pieces of flint glass, which, from being suddenly cooled by plunging them into water, had the interior entirely dislocated, and were merely held together by the exterior coating; portions of tubes showing the same effect; a portion of a vase of white glass dipped into blue glass of a greater density—in cooling, the interior white glass appeared to be crushed by the contraction of the exterior coating; a similar vase of white and blue glass of more equal density had cooled, and bore cutting without cracking.

The use of coke as a fuel, by the regularity of its combustion, assists materially in producing good results, and prevents the injury which frequently arises from a difference in the heating powers of various coals: unfortunately, the form of the furnaces causes the greatest heat to be in the centre, thus acting most powerfully upon the backs of the pots, instead of being equally distributed around them, which would be more desirable and would insure better results.

Mr. Pellatt still continued to use nine parts of coke mingled with one part of small coal in preference to any other fuel. He had abandoned the use of gas coke, and now purchased small coal at a low price, which he converted into a moderately-hard coke, rather less dense than that used for smelting iron. In the north of England, a charge of coal generally remained in the oven during 48 hours; in London, only 36 hours; he made lighter charges and coked them in 24 hours. He still found the calorific effect of 8 or 9 lbs. of coke to be equal to that of 12 lbs. of coal; in his ovens, 20 cwt. of coal produced 14 cwt. of coke.

Which was the best method of annealing tubes for water gauges on boilers? He generally used those prepared by Mr. Adie, of Liverpool, who annealed them by placing them in cold water and gradually raising the temperature to the boiling point, at which it was kept for 24 hours; yet, in spite of these precautions, which generally were successful, he had seen twelve of these tubes break in one day, while an apparently ill-made tube had lasted six weeks. He found thin tubes last longer than thick ones. He was in the habit of removing the stains of bog water from his boiler gauges by scouring them with emery; when reheated, they invariably broke; after many experiments, he tried the use of acid, which answered perfectly, and no tubes were subsequently broken.

RECORD OF PUBLIC WORKS.

Blackfriars Bridge.—Every one who has witnessed the improvements is highly gratified at the manner in which this great work has been accomplished. During the progress of the repairs and embellishments, some have complained of the apparent tardiness of the operations; but mere observers are not aware of the difficulties which have presented themselves in the thorough repair of such a structure, especially when it is recollected that the navigation has not been once stopped, and the carriage way for the first time closed for the purpose of lowering the declivities, and putting down a pavement beyond all comparison the finest in the metropolis. The committee did not confine themselves to the plan of merely repairing the bridge, but wisely directed their attention to the removal of the intolerable nuisance arising from the communication of the open sewer, called the Fleet Ditch, with the river at the north end of the bridge. It had been the subject of complaint that the sewers of the metropolis emptied their contents into the open air, almost at the level of high water, which contents were exposed for hours daily, generating putrefaction and malaria, so as seriously to endanger the health of the immediate vicinity. Mr. Walker, the engineer, recommended the plan of fixing an iron culvert, 12 feet wide, 3 ft. 6 inches deep, and 250 feet long, with a fall of five feet, to the extremity of the common sewer, in order to receive the filth and carry it (still under cover)

down to the low water of a low tide; and in the centre of the opening of the arch of the sewer, where it enters the river through the wing wall of the bridge, to hang three iron flaps, to move in and out by the action of the wind and water, and the space above to be covered with iron plates to prevent the escape of effluvia. This was recommended by the committee to the Court of Common Council, who referred it back to be carried into effect, and the work was nearly completed, when the Commissioners of Sewers raised some objection to closing the mouth of the sewer. The farther progress of the work therefore has received a temporary check.

Birmingham and Gloucester Railway.—The directors of this railway have determined to continue the line of the Tewkesbury branch from the station-house on the east side of High-street to the quay in that borough. To effect this object it will be necessary to widen Quay Street, and to erect a new bridge over the river Avon, near to the present iron bridge. The whole of the dwelling-houses and warehouses on the east side of Quay-street will accordingly have to be taken down preparatory to the widening of the approaches to the quay, and the extension of the railway.

Northern and Eastern Railway.—This railway line was opened on the 15th ult. as far as Broxbourne, a distance of 19½ miles from Shoreditch. It was determined that there should be no public display until the completion of the line to Bishop's Stortford. Its principal characteristic is the extreme flatness of the country through which it runs. For a great part of the distance the rails are laid almost upon the natural surface of the soil, and hence the construction averages only about £25,000 per mile. As a natural consequence of the character of the country, several roads cross the railway on a level, yet little additional expense will be entailed from this cause, as these generally occur close to the intermediate stations, of which there are no fewer than five within 11 miles from London; namely, at Lea Bridge, Tottenham, Edmonton, Ponder's End, and Waltham. The principal works upon the part now open are the engine-house near the junction with the Eastern Counties at Stratford, the iron bridge over the "Old Barge Cut" at Lea, and the station at Broxbourne. The first is a magnificent room on the model of a similar work at Derby, and the last a grand specimen of the Elizabethian style of architecture.

Manchester and Leeds Railway.—This railway is so far advanced that the communication between Leeds and Hebden Bridge will be opened on the 1st of October next, when the whole journey from Leeds to Manchester may be travelled by railway, with the exception of 10 or 11 miles, namely, from Hebden Bridge to Littlebro', which portion is expected to be completed in about a month or six weeks from that date. Sept. 19.

Stockton and Hartlepool Railway.—This line commences near Billingham, branching from the Clarence railway, with a gentle curve of half a mile in length over a low embankment, and then continues in a straight line through the village of Cowpon to the Greatham meadows, where occurs the Greatham viaduct, the principal work on the line. This consists of 92 semi-circular arches, built of bricks, with the exception of the cornice and coping of Ashlar stone; the middle arch being of larger dimensions for the passage of the brook or river. The length of the viaduct is about 700 yards.

South-Eastern Railway.—The works of this line may be considered under three divisions; first, that which extends between the point of junction with the Brighton Railway and Ashford; second, that from Ashford to Folkestone; and lastly, that between Folkestone and Dover. Considerable progress has been made in the first division, in which some heavy works exist, and the operations of construction are carrying on steadily and with apparently great attention to economy along the coast division; but the central portion has not yet been commenced, as from the very easy character of the works, comparatively but little time will be required for their completion. The line between Dover and Folkestone consists of works of considerable magnitude. First, there is a tunnel, of about seven-eighths of a mile in length, in Shakspeare's cliff; this is followed by sea-walling, of rather more than half a mile in length; then another tunnel occurs, of a mile and one-eighth in length, through Abbot's Cliff; afterwards there is a deep cutting, of one mile and five-eighths in length, through what is called the Warren. This is followed by a tunnel, of rather less than half a mile in length, in the hill on which No. 1, Martello Tower is situated. A lofty embankment joins the tunnel, and carries the line to Folkestone. From thence it recedes from the coast, and takes a direction towards Ashford. The tunnels under Shakspeare's Cliff and Abbot's Cliff will be entirely in chalk of the upper and lower formations. The Shakspeare Tunnel will consist of two parallel galleries, each 22 feet in width, with an interval of 10 feet between them. The sides are upright, and 22 feet in height, supporting Gothic arches, giving a total height from the line of rails of about 30 feet. The chalk is not of uniform tenacity; but wherever it has appeared to the engineer to be unsafe, he has supported the sides and arch by means of brick-work in cement, which is admirably executed. It was in the first instance imagined that the greater proportion of this tunnel would have stood without support; but these expectations have not been realized, and it is not improbable that the precautionary measures which the engineer has adopted will be carried to a still greater extent: for, although it may add somewhat to the cost in the first instance, it will be an expenditure that may ultimately promote the interests of the shareholders by increasing the confidence of the public. In forming this tunnel seven shafts were sunk from the upper surface to the level of the intended sole of the tunnel, and from thence small galleries were driven to the face of the cliff as a means of expediting the operation of forming the tunnels. That tunnel which is the nearest to the sea is in a much more forward state than the other, and the whole body of workmen now engaged in this part of the line are employed in carrying on the adjoining tunnel in order that it may be the first completed. The extreme height of the sea-wall will be about fifty feet. It will be composed of concrete, formed on the principle of the Brighton sea-wall, and of massive thickness. Twelve shafts have been sunk for the Abbot's Cliff Tunnel which is about to be commenced; the extreme depth of these shafts is 370 feet, and the average distance between them about 8 chains. The cutting through the Warren is in a considerable state of forwardness, and there is no doubt that the whole of this coast line might easily be executed in two years from the present time. Mr. Cubitt is the engineer-in-chief of the line, and Mr. Wright is the resident engineer of that portion of it which extends from Dover to a point about midway between Folkestone and Ashford. It may not be out of place to add that the accounts of the coast district are kept in so circumstantial and clear a manner as to exhibit a perfect record, not only of the expenses of every portion of the work, but also of the time employed in carrying it into effect; an example this which is well worthy of general imitation.

Derby Station.—The Derby station is one of the wonders of the railway system. The shed is so spacious as to cover nine several lines of rails; the walls which support the roof have open arches in their whole length; the entire width of the shed is about 140 feet, under three roofs, one of 56 feet span, and two of 42 feet span each. The roofs are of very light yet strong construction, containing an ample space of windows to enlighten the area below, and supported by 60 fluted cast iron columns, 22 feet high. The apex of the roofs is 38 feet high. The length of the main shed is 450 feet, but one of the roofs is prolonged by wings to the length of 1050 feet, by 42 feet wide. The shed is flanked on the right by offices of great extent, containing booking offices, waiting rooms, refreshment rooms, apartments for directors, and offices and warehouses for goods. This station is for the business of the North Midland, Midland Counties, and Birmingham and Derby lines. It is built and managed by the North Midland, the other companies paying them six per cent. on the cost for the use of it. But the offices and shed comprise only a small part of this wonderful station. The entire enclosure contains 26 acres of land. Each company has its own engine houses, carriage houses, and workshops, and these are on a magnificent scale, the engine house of the North Midland is thus described:—It is a polygon of 16 sides, and 130 feet in diameter, lighted from a dome-shaped roof of the height of 53 feet. It contains 16 lines of rails, radiating from a single turn-table in the centre: the engines on their arrival, will be brought in here, placed upon the turn-table, and wheeled into any stall that may be vacant. There are also carriage houses and workshops on a large scale, it being intended to repair everything on the spot. The latter buildings form wings to the polygon, 160 to 180 feet in length, and at a right angle to each other.

Railways in Germany.—The first section of the projected railways in the Grand Duchy of Baden was opened between Mannheim and Heidelberg, on the 28th ultimo, a distance of about 18 English miles. The Rhine has gained another bridge at Spires, an acquisition of no small interest, both in a military point of view and with regard to its utility in facilitating the communication with France, which in the course of next year is to be established by post coaches, running direct from Carlsruhe to Paris, without going round by Strasburg. The new bridge, like that of Mannheim, rests upon pontoons. In addition to the recently opened railway between Dresden and Magdeberg, by means of which the route from Hamburgh to Dresden can now be performed (with the help of the steamers), in three days, and that from Dresden to Hamburgh in two days; a new line is talked of, which is to bring Magdeburg in direct communication with the capital. With the Frankfort and Wiesbaden line, the states of the German commercial league have thus established, in the course of the present year, nearly 200 miles of railroad communication. The line between Aix-la-Chapelle and Cologne, which is to be continued to Maestricht on the one side, and to Dusseldorf and Elberfeld upon the other, will come into play next year, Sept. 14.

French Railways.—The number of passengers by the railroads from Paris, during the month of August, amounted to, from Versailles,

149,973; St. Cloud, Sévres, Courbevoie, &c., 66,872; and St. Germain, Nanterre, Ac., 145,060; making, in the aggregate, 361,910. During the month the receipts, by the St. Cloud and Versailles' road, amounted to 243,934f., and by that to St. Germain, 149,940f. "It is but a few years since, observes the *Moniteur Parisien*, "the whole receipts, by passengers, by ordinary conveyances to and from Versailles and St. Germain, produced less in twelve months than the above sum, realized in one."

Paris Railway Stations.—Three new railway stations, on a large scale, have been constructed at Paris—one for the Orleans railway, at the Boulevard de l'Hopital, another for the Versailles railway, at the Barriere du Maine, and a third for the St. Germain railway, in the Rue St. Lazare, by the side of the Tivoli passage.

Lombardo-Venetian Railway.—This work is to commence in Venice itself, by a viaduct 3800 yards, or above two miles long over the lagoons. It is to consist of 252 arches, is to carry the railway, paths for foot-passengers, an aqueduct, and the gas pipe. The expense is estimated at £180,000, and a large revenue is expected from it. Three short tunnels have to be made upon the line.

MISCELLANEOUS.

The London.—This fine ship, of 92 guns, was commenced in 1827, and is expected to be launched in the course of the present month, at Chatham. Her dimensions, &c., are as follows:—Extreme length, 242 feet; breadth, 54 feet, 3 inches; height aft, 57 feet, 6 inches; height afore, 50 feet, 9 inches; length of lower deck, 205 feet, 6 inches; depth of hold, 23 feet; tonnage, 2,602 tons. Lower deck: guns, six 68-pounders, each weighing 65 cwt., and 9 feet in length; twenty-six 32-pounders, each weighing 56 cwt., and 9 feet 6 inches in length. Upper: four 68-pounders, each weighing 65 cwt., and 9 feet in length; thirty 32-pounders, each weighing 56 cwt., and 9 feet 6 inches in length. Quarter-deck and forecastle: twenty-six 32-pounders, each weighing 41 cwt., and 8 feet in length; Congreves. Total, 92 guns. Total weight of metal, 3,304 lbs.; broadside, 1,652. The foremast is in length, 113 feet, 7 inches; and in diameter, 37 inches: the mainmast is 121 feet, 9 inches long, and 40 in diameter; the mizen mast is 77 feet, 8 inches long, and 26 in diameter. The bowsprit is 76 feet, 3 inches long, and 43 in diameter. Sept. 20.

Portsmouth, Sept. 10.—Mr. Deane, the diver, has recovered from the wreck of the Mary Rose, sunk at Spithead, about 1545, several valuable relics, among which is a piece of brass ordnance, 11 feet long, in a perfect state of preservation, valued at £200, with some stone shot, bows and arrows, and various other curiosities. This ship sunk after an action with the French fleet at Spithead, when they attempted to land at Portsmouth, or the Isle of Wight, and were defeated. It is doubtful, however, whether it was not at an earlier date than we have mentioned, perhaps, about 1512, when in an action off the coast, between the French and English, both the admirals' ships were burnt.

Experiment on Large Guns.—On the 11th ultimo a party of the Royal Artillery, commanded by Major Chalmer, proceeded to the proof butt, in the Royal Arsenal, Woolwich, for the purpose of trying a plan which has been some time in operation in France, for discharging large pieces of ordnance, by a hammer and detonating powder; the present system in the British army, being with a port-fire, ignited, and kept burning, until the word of command is given. Sir John May, Colonel Dundas, and Colonel Dansey, attended to witness the experiment. The gun was a 32-pounder, and the charge each time was 10 lbs. of powder, in a flannel cartridge, with a 32 lb. ball, fitted in a wooden cup, made flat at the end next the powder. Forty rounds were fired, and the simplicity and certainty with which they were discharged, gave general satisfaction. The invention is so simple, and might be so easily applied, that there is every reason to believe that it will be universally adopted in the ordnance department. It consists of a small hammer, with a handle about six inches in length; the whole made of brass, acting in holes, made in two small pieces of steel, fixed by screws to the right side of the gun. The action is given by pulling a piece of cord, six feet long, when the hammer falls on the vent charged with detonating powder, with such force as to cause instant and certain ignition. There is a small piece of steel to cover the detonating powder, that it may not become wet in rainy weather, and this is so contrived that it falls back the moment the hammer begins to descend.

The Steam-Ship Oriental.—This superb new vessel is the first of the new line of steam-vessels established by government, for the conveyance of the East-India mails, viâ Gibraltar. She is intended to run between Southampton and Alexandria, under the new contract with the government. This vessel is one of the finest models of naval architecture afloat, and her excellence as a sea boat has been amply displayed in her passage from Liverpool. It is said that she will prove a clipper, her average speed up channel having been twelve miles an hour, with all her stores, and the greater part of the coals for the voyage to Alexandria on board. The cabins are roomy, airy, and well-lighted—qualities indispensable to the comforts of a sea voyage. The saloon is spacious, and the decorations chaste and elegant. The Oriental is so constructed as to be at once convertible into a war steamer, carrying four 68-pounders, on swivels, and a formidable battery of broadside guns. The Oriental is of 1673 tons burden, and 450 horse power.

Salt Mine.—A salt mine has been discovered at Rheinfelden, in the Canton of Argau, which it is expected will be sufficiently abundant to supply all Switzerland, and thus save the Confederation the sum of 500,000*f.*, annually drawn from it for the purchase of foreign salt.—*Galignani.*

Chard Canal.—This undertaking, which has now occupied six years, is fast approaching completion. The whole extent of the line, with the exception of a mile and a half of its basin, is almost finished. The principal and only hazardous point now is the reservoir on Chard Common; here the attempts to make a bank have as yet failed, but increased labour and perseverance will, we trust, overcome the obstacle, and within a period of six months, we trust the reservoir may present an immense sheet of water, occupying a space of seventy acres. The expenditure on the works has been very great; during the last year £20,759 : 4*s.* : 9*d.* has been expended, and the whole expenses have been £26,479 : 16*s.* : 9*d.* Of the 1,140 new shares created by the committee in April last, 992 have been taken. The proprietors have now a very cheering prospect, as the committee expect the canal will be completed in the early part of next year.

Erection of a Safety Beacon on Goodwin Sands.—This desirable object has been accomplished, under the superintendence of Captain Bullock, of her majesty's steamer Boxer, and Captain Boys, superintendent of the Naval Store Department of Deal. Captain Bullock has been long engaged in carrying out the above object, and in the arduous duty of correcting the charts on various parts of the globe, and is now doing so under the authority of government on the waters of England. He commenced at Westminster Bridge, and proceeded towards Land's End, which is now undergoing his survey. The beacon he has erected consists of a column about 40 feet above the sea level, having cleets and ropes attached to four of its sides, with holds for hands and feet. At the summit of the column is attached a gallery of hexagon form, made of trellis work, and capable of holding twenty persons. Above the gallery, and in continuation of the column, is a flag-staff, 10 feet long; thus making the entire beacon 50 feet in height. The sides of the gallery are so constructed as to enable the persons in it to be covered in with sailcloth, which is reefed in and round it, and can be used at pleasure; as also an awning to pass over it, which is fixed to the flag-staff; thus entirely protecting any unfortunate mariner who may seek shelter on the column from foul and tempestuous weather. A barrel of fresh water, together with a painted bag, enclosing a flag of distress, is stationed on the gallery, and the words "Hoist the flag," painted in the language of all nations on boards, stationed round the inner part of the gallery, so that foreigners may be enabled to show a signal of distress, and obtain help from shore, which is about seven miles distant from the beacon. The means by which the beacon has been erected in such a hazardous place as the Goodwin Sands are as follows:—The foundation of the column is several feet below the surface of the sand, and is secured in the centre of a stout oak platform, from it several yards every way. This is secured by upwards of two tons of pig-iron ballast being lashed to it. In addition to this, eight stout iron bars, each six feet long, are drove obliquely on each quarter of the column, and two also put at a distance of 12 feet on each quarter, and chains attached to them, communicating with the upper part of the column, and the gallery. The sands, for three or four hours, during the tides, are high and dry, and present a fine tract of level extending for several miles. The indefatigable exertions of Captain Bullock, Captain Boyes, Lieutenant Harvey, and Mr. C. B. Yule, and the other officers and men engaged in the undertaking, are deserving of the highest praise, they being compelled to work for several hours immersed in the water. The beacon stands about seven miles from the town of Deal, and makes a very prominent object.

Removal of a Sand Bank.—Within the last five or six months, rather a strange phenomenon has occurred in the river Severn, and close to the little harbour of Lydney, where a large sand bank, of many acres in extent, which interfered with the navigation of that side of the river, and had for years compelled ships to keep more towards the opposite shore, has altogether disappeared; leaving the river clear at that side for ships of the largest burden, as it was some forty years before. This immense body of sand does not appear to have merely shifted to some other part of the channel, but has been entirely swept away, it is supposed, by the violent storms and rain in January and February last.

Naval Architecture.—It is worthy of remark, that the proportions of the British Queen steam ship, the last great effort of marine architecture that has interested the world, are exactly those of Noah's Ark,

proving that 4,000 years of practical science has done nothing to improve the dimensions of floating boats, first given by the Great Builder of the Universe; and, if the critical character of these proportions be duly considered, it may afford an evidence of the truth of the Scripture narrative; "the breadth of the ark was one-sixth of the length; the depth thereof one-tenth of the length." The British Queen is 40 ft. 6 in. wide; stem to sternpost 243 ft. aloft; whole depth, 29; making the square depth 24 ft. 6 in. The ark was twice as long as the Queen.

East Indies.—It is in contemplation to cut a canal from the Ganges through the Doab, lengthways; Captain Cantley has been employed for some time past, in surveying a level for it. The intended canal is to come out of the Ganges, above or about Hurdwar, and will be carried south of Coel and Mynpoorie. All classes are eagerly looking out for the commencement of such a source of irrigation, and although it is computed that ten years must be consumed in the execution, there is little doubt of every difficulty being overcome.—*Asiatic Journal.*

Cornish Engines.—A deputation from the Dutch government having visited Cornwall in order to ascertain by actual inspection whether the duty performed by the steam engines employed in the mines is equal to what is stated in the monthly reports, the adventurers and agents of the undermentioned mines kindly permitted an experiment of six hours, to be made on their several machines, and the duty as stated below was the result:—Wheal Vor, Borlase's engine, 80 inches single, 8,0 feet stoke, 123,300,593 lbs., lifted one foot; Fowey Consols, Austen's engine, 80 inches single, 9,0 feet stroke, 122,731,766 lbs., lifted one foot; Wheal Darlington egnine, 80 inches single, 8,0 feet stroke, 78,257,765 lbs. lifted one foot; Charlestown United Mines, 50 inches single, 7,5 feet stroke, 55,912,392 lbs. lifted one foot; Charlestown United Mines Stamping Engine, 32 inches single, lifting 66 stamps, 60,525,000 lbs. lifted one foot; Wheal Vor Stamping Engine, 36 inches double, lifting 72 stamps, 50,085,000 lbs. lifted one foot.—*Lean's Engine Reporter.*

Artesian Well.—The Artesian well at the abbattoir of Grenelle has been bored to a depth of nearly 500 metres (equal to 1700 feet). It appears from some new thermometric observations made by Messrs Arago and Walferdin, that the heat at the bottom of the well is 26 degrees higher than on the surface. This indicates an increase of nearly one degree for every twenty metres of depth.

LIST OF PATENTS.

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(SIX MONTHS FOR ENROLMENT.)

William Danbeny Holmes, of Cannon-row, Westminster, civil engineer, for "certain improvements in naval architecture, and apparatus connected therewith, affording increased security from foundering and shipwreck."—Sealed September 3.

Thomas Horne, of Birmingham, brass founder, for "improvements in the manufacture of hinges."—Sealed September 3.

James Bingham, of Sheffield, manufacturer, for "certain improved compositions, which are made to resemble ivory, bone, mother-o'-pearl, and other substances, applicable to the manufacture of handles of knives, forks, and razors, piano-forte keys, snuff-boxes, and various other articles."—Sealed September 3.

William Freeman, of Millbank-street, Middlesex, stone merchant, for "improvements in paving or covering roads, and other ways or surfaces," being a communication—Sealed September 7.

Thomas Motley, of Bath Villa, Bristol, engineer, for "improvements in apparatus, and means of burning concrete fatty matters."—Sealed September 7.

William Coltman, of Leicester, framesmith, and Joseph Wade, of the same place, framesmith, for "improvements in machinery employed in framework knitting, or stocking fabrics."—Sealed September 7.

John Whitehouse, the younger, of Birchall-street, Birmingham, brass founder, for "improvements in the construction of spring hinges and door springs."—Sealed September 7.

Samuel Parker, of Piccadilly, manufacturer, for "improvements in apparatus for preserving and purifying oils, and in apparatus for burning oils, tallow, and gas."—Sealed September 10.

Mark Freeman, of Sutton Common, Surrey, gentleman, for "improvements in weighing machines."—Sealed September 10.

Paul Hammic, of Clements-lane, London, solicitor, for "improvements in the construction of governors or regulators applicable to steam engines, and to other engines used for obtaining motive power," being a communication. Sealed September 10.

Charles Delbruck, of Oxford-street, gentleman, for "improvements in apparatus for applying combustible gas to the purposes of heat," being a communication.—Sealed September 10.

Edward John Dent, of the Strand, chronometer maker, for "certain improvements in clocks and other timekeepers."—Sealed September 10.

Henry Houldsworth, of Manchester, for "improvements in carriages used for the conveyance of passengers on railways, and an improved seat applicable to such carriages, and other purposes."—Sealed September 10.

Hugh Lee Pattinson, of Bensham Grove, Durham, manufacturing chemist, for "improvements in the manufacture of white lead."—Sealed September 10.

George Alexander Gilbert, of Southampton-buildings, Middlesex, for "certain improvements in machinery or apparatus for obtaining and applying motive power."—Sealed September 10.

Robert Goodacre, of Ullesthorpe, Leicester, for "an apparatus for raising heavy loads in carts, or other receptacles containing the said loads, when it is required that the unloading should take place at any considerable elevation above the ground."—Sealed September 10.

James Pilbrow, of Tottenham, engineer, for "certain improvements in steam engines."—Sealed September 10.

William Bedford, of Hinckley, Leicestershire, framework knitter, for "certain improvements in machinery employed in manufacturing hosiery goods, or what is commonly called framework knitting."—Sealed September 17.

Henry Fourdrinier, and Edward Newman Fourdrinier, both of Hanley, Stafford, paper makers, for "certain improvements in steam engines, for propelling ships, and other vessels, on waters."—Sealed September 17.

Moses Poole, of Lincoln's-inn, gentleman, for "improvements in preparing materials to facilitate the teaching of writing," being a communication.—Sealed September 17.

Walter Richardson, of Regent-street, gentleman, and George Mott Braithwaite, of Manor-street, Chelsea, gentleman, for "improvements in tinning metals," being a communication.—Sealed September 17.

Samuel Draper, of Nottingham, lace manufacturer, for "improvements in the manufacture of ornamened twist, lace, and looped fabrics."—Sealed September 21.

William Mill, of Blackfriars'-road, engineer, for "certain improvements in propellers, and in steam engines, and in the method of ascertaining and measuring steam power, parts of which improvements are applicable to other useful purposes."—Sealed September 21.

Charles Handford, of High Holborn, tea dealer, for "an improved edible vegetable preparation, called 'Eupooi,' and the mode of manufacturing the same."—Sealed September 21.

Thomas Pain, jun., of Seymour-street, Euston-square, student at law, for "a plan by means of which carriages may be propelled by atmospheric pressure only, without the assistance of any other power; being an improvement upon the atmospheric railway now in use."—Sealed September 22.

John Wrangham, of Connaught-terrace, Edgeware-road, gentleman, for "certain improvements in the construction of wheeled carriages."—Sealed September 24.

"George Goodman, of Henley, Birmingham, pin manufacturer, for "certain improvements in the manufacture of mourning and other dress pins."—Sealed September 24.

John Gibson and Thomas Muir, both of Glasgow, silk manufacturers, for "improvements in cleaning silk and other fibrous substances."—Sealed September 24.

William Hirst, of Leeds, clothier, for "improvements in the manufacture of woollen cloth, and cloth made from wool and other material." Sealed September 24.

Henry Pinkus, of Panton-square, Coventry-street, Esq., for "improvements in the methods of applying motive power to the impelling of machinery, applicable, amongst other things, to impelling carriages on railways, on common roads or ways, and through fields, and vessels afloat, and in the methods of constructing the roads or ways on which carriages may be impelled or propelled."—Sealed September 24.

John Johnston, of Glasgow, gentleman, for "a new method (by means of machinery) of ascertaining the velocity of, or the space passed through, by ships, vessels, carriages, and other means of locomotion, part of which is also applicable to the measurement of time."—Sealed September 24.

Pierre Erard, of Great Marlborough-street, Middlesex, for "improvements in piano-fortes."—Sealed September 24.

Thomas Robinson Williams, of Cheapside, in the City of London, gentleman, for "improvements in the manufacture of woollen fabrics, or fabrics of which wools, furs, or hairs are the principal components, as well as for the machinery used therein."—Sealed September 24.

Alexander Dean and Evan Evans, of Birmingham, millwrights, for "certain improvements in mills, for reducing grain and other substances to a pulverized state, and in the apparatus for dressing or bolting pulverized substances."—Sealed September 24.